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ONTARIO

Department of Education

Courses of Study

Grades IX, X, XI and XII

SHOP COURSES IN VOCATIONAL SCHOOLS

REVISED COURSES, INTRODUCED
IN SEPTEMBER, 1946

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SUGGESTIONS FOR THE USE OF THE COURSES

Outlines for the shop courses in vocational schools are provided herein. They are not necessarily arranged in order of presentation. They are designed for the maximum shop-work time as set forth in the Regulations, and on the assumption that five shop subjects will be offered in Grade IX. In schools where a larger or smaller number of shop subjects is offered the courses should be modified to suit the time available. In schools where it may be desirable to teach courses not specified in the outlines a synopsis of such courses of study shall be submitted for the approval of the Minister. In organizing time-tables, the semester plan is suggested in order to reduce the number of subjects carried concurrently by pupils.

The project is the usual basis for the presentation of shop instruction. Projects to cover the topics of the course should be selected with a view to the interests and abilities of the pupils and should offer sufficient variety. The well-directed use by the pupils of carefully planned shop libraries, illustrative materials, and other instructional aids will promote the close co-ordination of intelligent study with the performance of recognized standards in trade operations.

In planning and presenting instruction, teachers are asked to take into account previous training and experience which pupils have had whether in school or elsewhere.

The variety and quantity of the equipment available will determine the selection and arrangement of the topics from the following courses of study. From these courses the teacher should make a detailed organization of the work for each class. Frequent and systematic appraisal of the pupils' work should be made, giving credit for achievement in practical work, tests and examinations, home work, note book records, and if desired general adaptability to the instruction.

Pupils majoring in a shop subject shall take related shop subjects. To conserve shop time for shop work, the science, mathematics and drafting related to the various shop courses should be taken in the respective departments.

Unless provided for under the vocational guidance organization of the school, definite information with respect to the opportunities in the various related occupations and the particular job requirements should be made available to the pupils in order to assist them in making a wise choice of their future vocations.

Dangerous conditions affecting the health and safety of pupils in school must be avoided. Exhaust gases from running engines and fumes from spray guns and heat-treating processes must be effectively discharged. All machines must be properly guarded, safety instruction must be given in every shop where hazards exist, and a first-aid cabinet must be readily accessible. A clean and well-appointed shop, with equipment maintained in first-class operating condition, is an important factor in the prevention of accidents.

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GRADE IX

Exploratory Nature of the Courses

Pupils enrolled in a Vocational Shop Course are given training in a variety of shops in Grade IX, so that before entering the higher grades they may be able to select a particular shop in which they may complete the preparatory training necessary for admission to the trades and the industries.

GRADE IX COURSES

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AUTO MECHANICS

1. Chassis:
 - (a) Parts: examination and study to obtain the name, purpose and location of principal parts.
 - (b) Specifications: wheel base, spring suspension, steering-gear ratio, tread, and clearance.
2. Engine:
 - (a) Parts: identify parts, dismantle, and assemble a one-cylinder engine.
 - (b) Operation: events in the four-stroke cycle; combustion mixtures; properties and danger of carbon monoxide gas, precautions and artificial respiration.
3. Lubrication:

Simple theory; description, and examination of one system including dismantling and assembly.
4. Cooling System:

Radiator, pump, water-jackets; cooling fluids; examination of one system.

5. Electrical System:

Simple ignition system comprising battery, coil, breaker and spark plug. (To be confined to a one-cylinder engine; electrical circuit to be traced and operation observed without theory.)

6. Fuel System and Fuel:

- (a) Tank, pump, fuel lines, simple carburetor; common fuel line troubles.
- (b) Gasolene: use, precautions in its use, method of storing, methods of extinguishing fire; gasolene prohibited for cleaning purposes.

7. Fastenings:

Identification of bolts, nuts, cap screws, threads, rivets, washers, cotters; their use and application.

8. Transmission System:

- (a) Clutch: friction, single plate.
- (b) Gear box: standard positions, effect on drive shaft, speed ratios; elementary conception of mechanical advantage.
- (c) Drive shaft: types.
- (d) Rear axle: one type; differential, split axle, revolutions of wheels when turning corners, and gear reduction.

9. Running Gear:

- (a) Front axle: simple explanation; examination of unit for camber, caster, and toe-in.
- (b) Steering: one type, Ackerman principle.
- (c) Brakes: shoes, drums and linkages as applied to one wheel.

DRAFTING

1. Development of Drafting Skills:

- (a) The use and care of the elementary drafting instruments: T-square, set squares, pencil, scale, compasses.
- (b) The recognition, through use, of the following: outline, hidden outline, centre line, extension line, dimension line and arrow head.
- (c) The development of skill in single stroke freehand lettering: alphabet, figures, and fractions; size, slant and spacing, horizontal and slant guide lines. Application in notes and dimensions.

2. Working Drawings:

- (a) Freehand sketching of orthographic views from pictorial representations and objects to illustrate the correct placement of views on working drawings and the difference between working drawings and picture drawings.
- (b) Two and three-view working drawings to full size, or to scale 3 inches = 1 foot, of:
 - (1) Simple rectangular objects.

- (2) Angular objects which require straight lines only, such as wedges and tapers.
 - (3) Objects with curved surfaces involving circles and parts of circles; the locating and dimensioning of circular openings and holes.
 - (c) Dimensioning.
 - (d) Sections and half-sections; methods of indicating the section and the materials by cross-hatching.
 - (e) Geometrical constructions as required.
3. Detail and Assembly Drawings:
- (a) Assembly drawings of objects selected from the woodworking field; plan view, front view, side view, sections and scales as required.
 - (b) Detail drawings of simple machine parts to illustrate conventional indications for shop operations such as drilling, threading, tapping and finishing.
4. Development of Surfaces:
- Developing patterns for rectangular objects; parallel line development of patterns for cylinders (right and oblique cut), two-piece elbows and scoops.
5. Blueprint Reading:
- Examining simple drawings and blueprints of shop projects and other objects to learn the sizes, shapes, details, materials and processes as specified.

APPLIED ELECTRICITY

1. Circuits:
- (a) A complete circuit installation consisting of supply of current (dry cells or 6-volt battery), conductors, switch or push button, and load (sockets and lamps, or bell or buzzer).
 - (b) A circuit with a fixed load in which dry cells as a source of current may be added one at a time, (1) in series, (2) in parallel, and the general effect on the load observed and recorded.
 - (c) A circuit with a fixed source of current and the load units added one at a time, (1) in series, (2) in parallel, and the general effect observed and recorded.
 - (d) An annunciator circuit installation; other elementary signal circuits.
2. Joints, Soldering, Weatherproofing (introduced as required):
- (a) Making simple joints such as rat-tail, tee, and western union.
 - (b) Soldering, preparation of soldering iron and use of flux in soldering joints.
 - (c) Weatherproofing: taping and the use of compound.

3. Magnetism and Electro-magnetism:

- (a) Magnetic field about permanent magnets examined by use of iron filings or small compasses; study of polarity.
- (b) Making an electro-magnet; study of the magnetic field and polarity.
- (c) Examination of the field of force about a single wire carrying a current of electricity; development of "right hand rule."

- 4. Study of action of electric bells, buzzers, and annunciators.
- 5. Conductors and insulators: experimental study of a few common metals and non-metals as a basis for classification into conductors and insulators.
- 6. Circuit protection: heating effect of electric current; construction, purpose and rating of simple fuses (plug and cartridge type); an experiment to show safe current; carrying capacity of standard wires and cables used in the home.
- 7. Electrical units: sufficient experimental acquaintance with elementary circuits to gain the concept of volt, ampere, ohm, and watt.
- 8. Cost of electrical energy: determining the cost of operating common household heating appliances from name-plate reading; reading the kilowatt-hour meter and computing the cost of electrical energy.
- 9. Electrical equipment in the home: some general suggestions to get the best use from equipment such as heating appliances, lights and lighting equipment; electrical hazards and precautions to be taken.

MACHINE SHOP PRACTICE

1. Hand Tools and Bench Work:

- (a) Trade description of such tools and equipment required for this course as soft and hard hammers, chisel, punch, file, hack saw, taps and dies, and vise.
- (b) Operations such as sawing, use of hammer and chisel, filing, riveting, use of steel letters in marking, threading (taps and dies), edge and flat bending and forming.

2. Layout Work:

- (a) Coating of metal surfaces (copper sulphate, chalk) to facilitate layout.
- (b) Use of steel rule, dividers, scribe, hermaphrodite calipers, and punch in laying out work from blueprints or drawings; centering work for drilling.

3. Machine Operations:

- (a) Lathe:
 - (1) Identification of main parts only, such as headstock, tailstock, faceplate, centres, bed, carriage and controls.

- (2) Setting up work in machine, side facing, rough turning parting, turning to a shoulder, finish turning, use of calipers in turning to size, knurling, polishing and taper turning by offset method; use of chucks; end facing of work held in a chuck; lubrication of machine.
 - (b) Drill press:
 - (1) Operation, lubrication and maintenance of the machine.
 - (2) Centre punching of location for drilling, securing material in vise or V-block, sizes of drills and method of attachment in chuck, use of cooling and cutting compounds; precautionary measures to prevent damage to table and vise.
 - (3) Drilling to a layout, drawing holes to a desired location, countersinking.
 - (c) Grinder: safety precautions and use of goggles, rough grinding to remove hard skin of material, rough grinding to bring material to size.
 - (d) Power hack saw: setting up work, cutting to length, use of lubricants for cutting.
 - (e) Shaper: plain surfacing.
4. Fastenings:
- (a) Bolt and nut; rivet, round and flat head.
 - (b) Rivet-driving; forming head using snap and counter-sunk heads.
5. Hot Metal Working:
- (a) Operation of forge or furnace.
 - (b) Heating and working metals: simple exercises as required to complete project such as squaring round stock, drawing out a tang; effect of overheating.
 - (c) Simple hardening and tempering.
6. Finishing:
- Polishing, rustproofing, painting and enamelling; preparation and application.

PRINTING

- 1. The California Job Case and Contents:
 - (a) Character and purpose of the case.
 - (b) The lower case letters, plan and reason for arrangement.
 - (c) The capitals, numerals, punctuation marks, ligatures, signs, spaces and quads.
- 2. The Composing Stick:
 - (a) Kinds, parts and adjustment; use, care, and posture for setting.
 - (b) Pulling a proof in the stick.
 - (c) Distribution from the stick.
 - (d) Justification: simple flush lines.

3. Type:

- (a) Composition, parts, functions, fontage.
- (b) Characteristics of similar letters, how identified, type and print compared.
- (c) Point system of sizes and measurements.
- (d) Point system as applied to leads, slugs and other material.

4. Composition:

- (a) Spacing, justifying, centering, quadding.
- (b) Indention and justification as applied to regular paragraph work.
- (c) Poetry, flush, indented, turnovers, quotations.

5. Proofreading:

Correction of work with elementary introduction to the use of the principal marks and their meanings.

SHEET METAL

1. Materials:

- (a) Galvanized sheet iron and tin plate: reasons for different coatings on sheet iron, advantages and disadvantages of each coating; types of articles made from each metal; common stock sizes and gauges, comparison of thickness of sheets of different gauges used in the shop.
- (b) Solders: common (soft) solder, composition; reasons for different alloys used for solder; uses of common solder and special solders.
- (c) Soldering fluxes: purpose and reaction of soldering fluxes with common metals; types of fluxes used on common metals; the use of muriatic acid, sal-ammoniac, soldering paste and rosin; making zinc chloride (killed acid).

2. Hand Operations and Tools:

- (a) Laying out: use of squaring, measuring and marking tools; method of laying out from a straight edge and a centre line, use of templates; adding seaming allowances for lap and grooved seams, and reinforced edges.
- (b) Cutting: use of straight snips for cutting on straight lines and curved lines; notching and cutting for hinges; use of cutting pliers for wire cutting; care of cutting tools.
- (c) Folding and forming: proper use of mallet and setting hammer in forming metal over stakes; use of hollow mandrel, beakhorn or improvised stakes for bending along straight lines in the construction of simple straight-lined objects.
- (d) Wiring: allowance required for various sizes of wire used in reinforcing edges; preparatory bends, forming wire, use of mallet and setting hammers for hand wiring; necessary precautions to avoid damaging metal during wiring operations; location for ends of wire.

- (e) Grooving: use of hand groovers; seaming allowance required, width, type and direction of folds on edges to be joined; locking ends for proper alignment of folds; operation of grooving a seam.
- (f) Soldering:
 - (1) Soldering iron: purpose, conductivity of copper, oxidation, tinning a soldering iron.
 - (2) Soldering: heat required; correct position and movement of soldering iron over a seam, penetration of solder into a seam; fusing solder into a metal.

3. Machine Operations:

- (a) Foot squaring shears: cutting on a line, squaring stock; use of side, back and front gauges; types of material which may be cut in shears; safety precautions.
- (b) Adjustable bar folder: types of folds (open, close and double); setting and locking gauge; use of stops for various angles.
- (c) Bending brake: method of operating for bending material in the construction of simple straight-lined objects.
- (d) Roll former: feeding metal between rollers, adjusting rollers for tension on metal and for forming metal into cylindrical objects of various diameters.

4. Sheet metal finishes: methods of preparing various sheet metals to take protective and decorative finishes.

WOODWORKING—GENERAL

1. Materials:

- (a) Lumber: classification of lumber—open and close grain, general purpose and miscellaneous woods; stock sizes; units of measurements.
- (b) Glues: source, preparation and application.
- (c) Hardware: nails (common and finishing); wood screws—flat, oval and round-head; hinges—butt, strap and tee; various types of catches.
- (d) Finishing materials: elementary supplies; stain, shellac, paint and enamel.

2. Hand Tools and Operations:

- (a) Laying out: economical selection of stock; use of try-square, marking gauge and marking knife.
- (b) Sawing: rip and cross-cut.
- (c) Planing: surfaces, edges, ends; at an angle to grain, chamfering, rounding.
- (d) Chiselling: paring, chamfering, rounding; perpendicular chiselling; cutting a hand mortise; use of mallet.
- (e) Shaping: use of coping and compass saw; use of spokeshave and file.
- (f) Boring: use of brace, hand drill and various types of boring bits

- (g) Fastening: use of common and finishing nails, screws, corrugated fasteners, clamp nails; use of various types of clamps.
- (h) Sanding: use of abrasives such as sand and garnet paper.
- (i) Sharpening: whetting plane irons and chisels.

3. Machine Tools and Operations:

The machines must be adequately guarded and the guards must be in place. Operations that cannot be completed with the guards in place must not be attempted by the students.

- (a) Lathe: rough and finish turning to size; shoulder and taper turning, turning simple beads and curves; face-plate turning; use of calipers and templates.
 - (b) Jig sawing: sawing simple scrolls.
 - (c) Band saw: use of saw in cutting curves; adjustment of guards.
 - (d) Mortiser: vertical mortising.
 - (e) Router: use of the hand router for simple moulds.
4. Finishing: preparation and application of stain, shellac, paint and enamel; application of wax (mission finish); care of brushes.
5. Trimming: applying small knobs, hinges and catches over a finished surface.

FARM MECHANICS

1. Drawing and Plan Reading:

- (a) Measuring and sketching: simple objects in full scale to include placement of views, representation of visible and invisible surfaces, dimensioning and lettering; scale drawings, elementary geometrical construction and lettering as required.
- (b) Reading blueprints: a study of complete drawings of simple, useful farm or home equipment to assist the pupils in picturing the object, locating dimensions and estimating the cost.

2. Woodwork:

- (a) Common hand tools: construction, uses, adjustment and upkeep.
- (b) Materials:
 - (1) Uses and recognition in the rough and the finished state of at least six woods; warping and checking of woods, how caused and counteracted.
 - (2) Identification of nails, wood screws and other hardware in common use.
- (c) Operations: use of saw, plane, chisel, and try-square in squaring stock to size and making joints such as rabbet, mitre, mortise and tenon; the making of at least three articles useful in the home or garden or on the farm, such as bread-board, neck-tie rack, coat-hanger, flower trellis, bench-hook, nail box, milking stool, chicken feed hopper, bird house or harness-stitching clamp; the study of the tools and construction of the joints to be introduced in the pupils' projects.

3. Paints and finishes: paints for wood, iron, and concrete; home-mixed and ready-mixed paints; preparation of surfaces; the uses of shellac, varnish and wax in finishing; the care of brushes.
4. Rope work: kinds and grades of rope; uses of rope on the farm; care of rope; common knots and their uses; whipping a rope end, crowning and tucking a rope end; making a short splice, long splice and eye splice.
5. Belt lacing: leather and fabric belts; care of belts; tools required in belt lacing; making of samples of single lacing and double lacing using cardboard and cord.
6. Harness repairing: importance of keeping harness in good condition by cleaning, oiling and repairing at least once a year; tools and materials needed; making a waxed thread and practice in stitching splices; attaching snaps and buckles.
7. Glazing: tools, preparation of putty; value of priming coat on sash; methods of cutting glass; practice in putting glass in new sash or in replacing glass in a broken window.
8. Pipe-fitting:
 - (a) Kinds of pipe: black and galvanized iron.
 - (b) Operations: cutting, reaming, threading, sealing joints; use of couplings, elbows, tees, reducers; measuring runs and making layouts.

COURSES OF STUDY

GRADE X

Pupils enrolled in Vocational Schools may be given an opportunity in Grade X to select a particular shop in which they may, according to a plan outlined, continue the preparatory training necessary for admission to the trades and the industries.

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AUTO MECHANICS

The course of study is to deal in greater detail with the names, purpose, location, and operation of the principal parts of the modern automobile, and to provide for simple fitting and adjusting during assembly and replacement operations. One or more running engines are required.

Safety instruction relating to the proper handling of machine and hand tools, gasoline and lubricants, including the stressing of the dangers of carbon monoxide gas, should be emphasized.

1. The Multi-cylinder Engine:

- (a) Piston assembly: relative position of pistons in various cylinders, relative piston pressures; detailed examination of pistons, rings, connecting rods and bearings.
- (b) Crankshaft: types, relation to stroke, r.p.m., length of stroke in degrees.
- (c) Valves: arrangement as to heads, seats, faces, springs, locking, guides, tappets and clearances; timing valves with and without marks; valve lap, lead and lag.
- (d) Horsepower: brief reference to horsepower formula as used for license purposes.

2. Lubrication:

Study of a lubrication system for modern automobile engine and chassis; kinds of lubricants, lubrication charts, S.A.E. gradings, effect of extreme temperatures, filters.

3. Cooling System:

Types, parts and function of each; anti-freeze solutions and testing.

4. Electrical System:

Identification of component parts for a four-cylinder engine, including ignition, generator, starter, and lighting circuits; wiring up of the above-mentioned circuits with and without wiring diagram, using unidentified wire.

5. Fuel System:

Fuel pumps, strainers, carburetor (detail adjustments on one type): fuel properties, significance of octane ratings.

6. Transmission System:

- (a) Clutch: detailed examination of a single-plate dry clutch; adjustment of clutch.
- (b) Gear box: path of power, relative speeds of crank and drive shaft for different gear shift positions; mechanical advantage, and direction of drive.
- (c) Drive shafts: examination of two types; need for universal joint, kinds of universal joints.
- (d) Rear axles: types; more detailed study of differential, including variation in speed of rear wheels due to resistance; gear reduction, ratio of speed of rear wheel to ring gear.

7. Running Gear:

- (a) Front axle: types; principal parts including king pins, steering knuckle, bearings, tie rod, drag link; more detailed study of Ackerman principle, including pivot or king pin inclination, camber, caster, toe-in and steering-gear reduction.
- (b) Brakes:
 - (1) Mechanical: a study of complete mechanical unit with linkage for four wheels.
 - (2) Hydraulic: a study of operation of master cylinder and wheel cylinder in actuating brake linkages.

DRAFTING

1. Working Drawings:

More advanced problems involving placement and dimensioning of views, auxiliary views, revolved sections, symbols of materials and bills of materials. The drawings to be selected from shop projects when suitable. The making of sketch plans before starting the scale drawings to be encouraged.

- (a) Architectural drawing: simple building details such as brickwork, foundations, walls, doors, windows, stairs, fireplaces and kitchen layouts; plans, sections and elevations of frame construction; details of a small frame structure such as garage, summer cottage or farm building; conventional representations used on floor plans for details such as windows, doors, electrical outlets, plumbing and heating.

- (b) Machine drawing: detail drawings of handles, pulleys, face-plates, couplings, bearings, cranks, glands, fastenings or similar mechanical devices; conventional indications used in plan, elevation and section views for tapped, blind, bored, countersunk, counter-bored and cored holes; indications as required for other machine operations and for materials used in machine parts; detail and assembly drawings of simple machines such as the vise, clamp, and press; layout of pipe lines, calculation of lengths, selection of fittings for pipe handrails and pipe racks.

2. Orthographic Projection:

Problems to illustrate the principles of projection: objects with surfaces not parallel to one another, obliquely cut objects such as frustums of pyramids and cones; auxiliary views; incomplete views.

3. Intersection of Surfaces:

Plotting the lines of intersections of cylindrical and rectangular shapes joining at various angles such as in tee and branch pipes.

4. Development of Surfaces:

Radial line development applied to conical and pyramidal shapes; extension of parallel line development to three and four-piece elbows; developments involving a combination of both methods for pattern layout; allowances for laps and seams.

5. Geometrical Constructions:

Drafting problems involving such layouts as the hexagon, octagon, and pentagon, the division of circles and lines, and the bisection of angles and lines.

6. Isometric Drawing:

Principles of isometric drawing, the boxing and offset methods; circles in isometric.

7. Map or Topographical Drawing:

Drawing of a land plot from field sketch and notes; indications for topographical features.

8. Blueprint Reading:

Reading drawings representative of the shop work taught in the school and of the local industries. Problems to be arranged to require the preparation and study of lists of the materials and processes indicated on the drawings.

9. Tracing and Blueprinting:

For the student who makes rapid progress in drafting: inking, tracing and blueprinting.

NOTE:—Where pupils are allowed to major in either Architectural or Machine Drawing in Grade X, Part (a) or (b), Topic 1, is to be expanded. Where pupils are majoring in a designated shop, the drafting projects for these pupils are to be related to their shop work.

APPLIED ELECTRICITY

A. INSTALLATION AND MAINTENANCE

The course should be closely connected with, and the workmanship should conform to, the requirements of the Hydro-Electric Power Commission of Ontario.

1. Splices and Joints:

Proper construction and uses of common splices and joints including cable splicing, soldering, taping, and waterproofing; sweating of terminal lugs.

2. Materials:

Study of the B. and S. gauge wire tables; recognition of commonly used wires and cables according to size, insulation and use; identification by name, size and description of other trade materials within the scope of this course.

3. Circuits:

(a) Bell and annunciator circuits: ground return, parallel operation, return call, three or four-point annunciator, master control bell system, and other similar circuits.

(b) Light and power circuits: construction (knob and tube) of the elements of lighting circuits such as might be suitable for a seven-roomed house; construction in non-metallic sheathed wire and cable.

4. Testing and Repair:

Elementary testing and repair of simple electrical appliances. The testing referred to in this course is to be confined to the use of journeyman's test equipment.

B. THEORY AND TEST

1. Magnetism:

(a) A more extensive study of this topic by the mapping of the fields of force about permanent magnets as used in electrical apparatus and equipment.

(b) Plot fields of force about conductors carrying current to develop the right hand rule and helix rule; effect of increasing (1) turns, (2) current through a coil of wire having an iron core; electro-magnetism as applied in electric bells, relays, circuit breakers, and lifting magnets; air gap, permeability, saturation and residual magnetism.

2. Conductors and Non-conductors:

A more advanced study and experimental determination of ability of common metals, non-metals, and solutions to conduct current.

3. Heating effect of electric current; circuit protective devices (fuses and thermal cut-outs).

4. Instruments (the D.C. ammeter and voltmeter):

Principal parts, construction, principles of operation, location in the circuit and precautions for proper use.

5. Ohm's Law (experimental study):
 - (a) Effect on current in circuit by varying resistance and holding voltage constant.
 - (b) Effect on current in circuit by varying voltage and holding resistance constant.
 - (c) Development of equations.
6. Resistors, Resistance Measurement, Circular Mil Measure:
 - (a) An examination and study of common resistance materials as found in household appliances, such as lamps, motors, motor starters and heaters.
 - (b) Measurement of the resistance of such appliances by the volt-ammeter and Wheatstone bridge methods.
 - (c) Comparison of wire diameters with standard tables; comparison of mil foot resistances of wires in common use.
7. Circuits:

Determination of current, voltage, and resistance characteristics of typical series and parallel circuits.
8. Voltage Drop:

Measurement of voltage drop in simple electric circuits for light, heat and power.
9. [Measurement of Power:

Three methods: volt-ammeter, wattmeter (kilowatt-meter), and watt-hour (kilowatt-hour) meter; horse power in terms of kilowatts.
10. Losses in Electric Circuits:

Copper losses in field coils, armatures, and transmission lines.
11. The D.C. Generator:
 - (a) Elementary laws governing the direction and relative values of induced currents in conductors cutting magnetic fields.
 - (b) Simple D.C. shunt-wound generator, parts and their functions.
 - (c) Characteristic tests; no load voltage characteristics with variation of field strength (separate constant excitation), variation of terminal voltage with variation of load current (self-excitation).

MACHINE SHOP PRACTICE

1. Hand Tools and Bench Work:
 - (a) Use of different types of blades in the hand hack saw with a view to proper selection.
 - (b) Filing to size with greater attempt at the production of flat surfaces.
 - (c) Threading by use of taps and dies.
2. Layout Work:
 - (a) Coating of metal surfaces to facilitate layout.
 - (b) Use of scale, scribe, centre punch, calipers, surface plate and surface gauge.

3. Machine Operations:

- (a) Lathe: taper turning by means of taper attachment; spotting and drilling; filing and polishing; thread cutting—external N.C. thread.
- (b) Drill press: selection of proper drills (carbon and high speed) for different materials and speeds; use of various cutting agents for different materials; drilling to a depth; countersinking; finishing work by emery stick head; spot facing.
- (c) Shaper: shaping of horizontal, vertical, and irregular surfaces.
- (d) Miller: milling a flat surface.
- (e) Grinder: more detailed study of abrasives as to properties, selection and use; grinding lathe tool bits to sample and gauges.

4. Hot Metal Work and Elementary Metallurgy:

Forging, cutting, bending, punching, drawing, upsetting, hardening, tempering; shop tests for the distinguishing characteristics of common metals; machine and hand work in brass, bronze, and babbitt to acquaint pupils with the fundamental properties and uses of these alloys.

5. Fasteners:

An examination of such fasteners as rivets, bolts, cap screws, set screws, taper pins and keys for purposes of identification and knowledge of their special uses.

6. Repair and Maintenance:

- (a) Belts: care, selection, proper operation and splicing; power transmission.
- (b) Lubrication: bearing types; grease and oil fittings, and special lubrication required.

MINING

A. MINERALOGY

1. Introduction:

- (a) Definition and importance of minerals.
- (b) Physical properties of minerals used in identifying them in hand specimens:—colour; lustre; streak as obtained on a streak plate or by powdering; hardness; the scale of hardness with practice in estimating hardness of mineral specimens by a steel knife; specific gravity; parting; cleavage.

2. Description of Minerals:

Properties, uses of, localities where mined, and practice in spotting the following minerals:—galena, quartz, feldspar, calcite, talc, gypsum, mica, hematite, magnetite, limonite, siderite, silver, bauxite, corundum, fluorite, apatite, topaz, smaltite, niccolite, hornblende, pyroxene, chalcopryite, gold, pyrrhotite, pentlandite, graphite, molybdenite, cinnabar, copper, pyrolusite, arsenopyrite, halite, serpentine, sulphur, stibnite, argentite, chalcocite, barite, arsenic, bismuth, platinum, cassiterite, bornite, marcasite, cryolite, ilmenite, spinel, chromite, dolomite, ankerite, magnesite, garnierite, uraninite, epidote, kaolin, sodalite, olivine, garnet, chlorite.

3. Classification of Above Minerals According to Chemical Composition.

B. GEOLOGY

1. Introduction:

Science related to geology; origin of the earth; structure of the earth; forces within the earth; causes of liquefaction of the interior; causes of intrusion of igneous rocks.

2. Rocks:

- (a) Definition, classes and general characteristics.
- (b) Igneous rocks:—characteristics and general method of formation of coarse grained, fine grained and volcanic rocks; forms of igneous rocks such as bosses, dykes, sills, sheets, laccoliths, volcanic necks and batholiths; kinds of igneous rocks with description and practice in recognition of plutonic rocks such as granite, pegmatite, syenite, diorite, hornblendite, gabbro, norite, pyroxenite, diabase, peridotite and dunite; description of fine grained rocks such as basalt, felsite, rhyolite and of volcanic rocks such as obsidian, tuff, breccia and agglomerate.
- (c) Sedimentary rocks:—characteristics and general method of formation; agencies producing sediment as weathering and erosion; collecting agencies; chemical sediments; minerals of sedimentary rocks; kinds of sedimentary rocks with description and recognition of such rocks as conglomerate, greywacke, sandstone, arkose, shale and limestone.
- (d) Metamorphic rocks:—general characteristics and methods of formation by chemical, dynamic and structural changes; kinds of metamorphic rocks with description and recognition of gneiss, quartzite, schist, slate and marble.

3. Structural Geology:

- (a) Geological structures common to all rocks such as bedding planes; joints; folds, including anticlines, synclines, monoclines, series of folds; compound folds; method of formation of folds.
- (b) Faults:—definition; normal fault; reverse fault; rotational fault; causes of faults; results of faults.

4. Movements of the Earth's Crust:—kinds, evidences, earthquakes; unconformities; causes; results.

5. Field Trips:

Wherever possible the various kinds of rocks, rock formations and geological structures are studied in the field.

C. CHEMISTRY

1. General Chemistry:

- (a) Chemical substances and properties:—first law of chemistry, physical and chemical properties, use of burner and shaping glass tubing.
- (b) Chemical change:—difference between physical and chemical change, chemical combination, chemical decomposition, solutions and solubilities, law of definite proportions.

2. Preparation and Collection of Gases:

A study of the method of preparation and different methods of collecting oxygen, hydrogen and carbon dioxide.

3. Atomic and Molecular Theories:

- (a) Mechanics of chemicals.
- (b) Synthesis and analysis.
- (c) Elements:—symbols, valence, groups, i.e. metallic and non-metallic.

4. Use of the Chemical Balance.

5. Making Formulae—Binary Compounds:

- (a) Law of definite proportions.
- (b) Law of conservation of matter.
- (c) Writing of equations.

6. Acids:

- (a) Preparation and properties of:—hydrogen chloride, hydrochloric acid; nitric acid, sulphuric acid.
- (b) General properties of acids.
- (c) Naming acids: binary, oxygen, and formulae.

7. Bases:

- (a) Preparation and properties of sodium hydroxide, potassium hydroxide, calcium hydroxide.
- (b) Definition and naming of bases.
- (c) General properties.
- (d) Writing formulae.

8. Salts:

- (a) Naming and writing formulae.
- (b) Water of crystallization, deliquescence, efflorescence, hydrolysis.

9. Preparation and Properties of Industrial Gases:

Chlorine, carbon monoxide, ammonia, sulphur dioxide, hydrogen sulphide.

10. Miscellaneous:

- (a) Chemical arithmetic: problems involving weights of substances and volumes of gases taking part in chemical reactions.
- (b) Oxidation and reduction reactions.
- (c) Molar solutions, equivalent weights and normal solutions.

PRINTING

1. Elementary Composition:

- (a) Dumping and tying up: methods, precautions and development of skill.
- (b) Pulling proofs on the galley: advantages, procedure and standard of cleanliness necessary.
- (c) Distributing from the galley.
- (d) Correcting in the stick and on the galley: general classification of corrections and proper procedure; special corrections, including over-running and leading.
- (e) Paragraph composition: rules for lines, indentation, general procedure to gain uniform appearance and easy reading; justification.
- (f) Punctuation marks and spacing: standard practice for the spacing of the period, comma, hyphen, colon, semi-colon, exclamation, question, apostrophe, dash, parentheses, and brackets.

2. Proofreading: symbols, use of symbols in study of a proofread model, assigned proofreading.

3. Special Composition:

- (a) Setting poetry: special indentions, justification, general rules and exceptions.
- (b) Numbering sentences: alternate use of numbers and letters.
- (c) Setting indentions: review of regular paragraph indention and extension of study to include hanging, half-diamond, squared and diagonal.
- (d) Setting numbers: three ways of expressing number, rules for comma, usage and examples of correct usage.
- (e) Tabular composition: rules for procedure in setting up a simple example of tabulated form.
- (f) Multiple justification: advantages and procedure.
- (g) Initial letters: history, purpose, extent of use, rules for use in composition.
- (h) Leaders and rules: examples, purpose, procedure for composition.
- (i) Borders: purposes, common types, margins, procedure for making butted rule border and mitred border.

4. The point system: brief history, advantages, units, applications to types and materials.

5. Book Composition:

A booklet in loose-leaf form introducing the following features of book composition: preliminary pages (title pages, advertising card, copyright, dedication, preface, contents, list of illustrations, introduction, half title); chapter heads, initial letters, running heads, sub-heads, leading, over-running, numbering, tabular forms, multiple justification; use of rules, borders, cutting and mitring machines; indentions, side notes, cut-in notes and concluding pages.

NOTE:—It is intended that “book composition” or some similar project should incorporate all the operations referred to in the course.

6. The press: brief history, general types, principles of operation, proper care, and general experience in the safe operation of a platen press.

SHEET METAL

1. Materials:

- (a) The common properties, uses, limitations, methods of manufacture, approximate unit cost and stock sizes of the common sheet metals, such as black iron, steel, galvanized iron, tin plate, zinc and copper: reference to be made to the action of acids on these metals.
- (b) Fluxes: types, special uses, preparation of fluxes for the metals listed in (a).

2. Hand Operations and Tools:

- (a) Laying out: transferring dimensions from a blueprint or drawing to the sheet metal in preparation for cutting; use of indentations for locating bending lines on reverse side of material; adding seaming allowance for double seams.
- (b) Cutting: use of straight and curved snips; shearing with chisel and vise.
- (c) Folding and forming: use of bench stakes and tools such as hollow mandrel, blowhorn, conductor or improvised stakes in forming cylindrical and conical-shaped objects.
- (d) Riveting: use of rivet sets and punches; weights and sizes of rivets, spacing and punching rivet holes; blind riveting, forming rivet heads.
- (e) Soldering: selection of soldering iron, selection of proper fluxes; study of melting points of various solder alloys; proper application of solder to various types of seams.
- (f) Double seaming: metal allowance required, preparatory folds, proper stakes, method of turning seam with mallet, drawing metal back from folds, squaring and tightening seams.
- (g) Copper work: beating, annealing, pickling, polishing, lacquering or waxing, soldering, tinning and sweating.

3. Machine Tools and Operations:

- (a) Names of main parts, proper use, adjustments, and precautions to be observed for the foot squaring shears, bending brake, adjustable bar folder, slip roll former, and the wiring, burring and turning machine.
- (b) Operations: folding, locking, wiring, turning and burring of flat and cylindrical work.

WELDING

(OXY-ACETYLENE AND ELECTRIC ARC)

NOTE:—These courses should be reduced when used for lower grades.

A. OXY-ACETYLENE WELDING

1. Equipment:

- (a) General: colour standards, fittings and thread types; manifold systems; safety precautions.
- (b) Welding blow torches: low and medium pressure types; welding heads and gas pressures; selecting suitable heads.
- (c) Regulators: types, single and two stage (stem and nozzle); structure; function.
- (d) Gases: properties and manufacturing methods of oxygen and acetylene; construction of commercial cylinders and volume measurement.

2. Lighting a Blow Torch:

Procedure, types of flames and their effects upon metals, manipulation and torch movements including proper position when welding; lines of fusion on sheet iron, penetration; use of filler rod in laying beads on flat surface.

3. Types of Welded Joints:

Butt, fillet and tack welds; use of tables. Practice work in making test joints in sheet iron including butt, corner, tee, edge and lap types. Application of these types in the fabrication of welded structure.

4. Brazing:

Description of process; materials used and preparation of the work; practice exercises on sheet iron.

5. Cutting with Blow Torch:

Theory of cutting action and practice exercises in straight line cutting.

B. ELECTRIC ARC WELDING

1. Classification:

- (a) Energy: direct and alternating current.
- (b) Heating: arc and resistance.
- (c) Electrode: carbon, graphite, metallic and shielded arc.

2. Safety Precautions and Equipment: shields, screens, clothing; electrical hazards.

3. Auxiliary Equipment:

Cables for ground and electrode connections, ground plates and methods of securing, types of electrode holders and methods of using.

4. Energy Supply—elementary study of commercial equipment:

- (a) D.C. generator sets.
- (b) A.C. transformer sets.

5. Direct Current Welding:

- (a) Control and operation of the equipment including straight and reversed polarity.

- (b) Practice exercises in running beads: study effect of length of arc on welded deposits.
 - (c) Practice exercises in butt, corner and tee joints on Number 10 gauge sheet iron.
-

WOODWORKING—CABINET-MAKING

1. Materials:

Lumber: pine, birch, maple, bass, gum, and walnut; three methods of curing (drying) namely, open-air drying, hot-air kiln drying, hot-air steam-jet drying.

2. Hand Tool Operations:

- (a) Sanding flat surfaces and moulded edges: use of flat sanding block (cork face).
- (b) Repairing damaged stock in the white wood.
- (c) Use of block, rabbet and router planes.
- (d) Assembling case goods.
- (e) Filling nail holes: preparation and use of fillers such as glue and sawdust, bees'-wax and sawdust, shellac and silex, stick shellac.

3. Machine Tools and Operations:

- (a) Cut-off saws: swing and straight-line sawing; cutting material to its rough length, use of stop blocks; setting up the machine.
- (b) Variety saw: operation and adjustment; ripping to width; tenon sawing; cross-cutting; sawing rebates; taper sawing; types of teeth for ripping and cross-cutting.
- (c) Jointer: operation and adjustment; buzz planing (surfacing), edge jointing; glue jointing of matched stock.
- (d) Planer: planing stock to finished thickness; planing thin stock; taper planing.
- (e) Band saw: adjustment of saw, tracking and tension; laying out work to avoid waste and for economy of sawing; use of jigs: folding the saw.
- (f) Mortiser: hollow chisel mortising, blind and through mortising; use of horns where mortise comes near end of stock.
- (g) Lathe: spindle, face and chuck turning; turning to a template; sanding turned work; special set-ups.
- (h) Grinder: grinding edge tools.
- (i) Boring machine: vertical and horizontal boring.

4. Upholstering:

Hard-seat covering: use of tow stuffing, muslin covering, leatherette covering; gimping and tacking.

5. Finishing:

- (a) Water and oil stains.
- (b) Mixing filler for a natural finish; use of silex, boiled oil, Japan drier, turpentine.
- (c) Shellacking, varnishing, water and oil rubbing; spiriting off.

WOODWORKING—CARPENTRY

The trade of carpentry is divided into three divisions: bench work, construction, and interior trim. Much of the work for this grade should be of the bench type.

1. Materials:

Lumber—classification as to rough work (concrete forms); exterior work such as studding, rafters; outside trim and interior trim such as casing, base-boards. Cost of material.

2. Hand Tool and Bench Work:

- (a) Rabbetting: planing a rabbet, using rabbet plane and guide strips.
- (b) Mortising: cutting a hand mortise (using mortise chisel) and tenon.
- (c) Hand dadoing: cutting dado across grain using guide strips, tenon saw and router plane.
- (d) Beading: cutting a bead by use of beading plane.
- (e) Hand mitring: mitring frame with rabbetted inside edge.
- (f) Sawing: cross and rip sawing; use of compass saw in cutting circular work.
- (g) Framing: the framing square; use of brace measure table, Essex board measure; laying out a common rafter; roof terminology, roof pitches.
- (h) Fitting butt, tee, strap and surface hinges, hasps and catches.

3. Machine Operations:

- (a) Variety saw: ripping, cross-cutting, grooving, dadoing, rabbetting; jigs for angle sawing.
- (b) Hollow chisel mortiser: set up and adjustment; mortising.
- (c) Boring: use of various types of boring bits; setting up and adjusting.
- (d) Band saw: operation and adjustment; resawing.
- (e) Sanders: operation and adjustment of drum and belt sanders.

WOODWORKING—PATTERN-MAKING

The pattern equipment to include materials and supplies for moulding, core making and pouring of soft metals.

1. Study of materials:

- (a) Pattern lumber: characteristics, identification, workability, warp, wind, shrinkage, shake and wind check.
- (b) Fasteners:
 - (1) Glue: kinds and preparation.
 - (2) Screws: types, sizes and specifications.
 - (3) Nails and brads: specification and application.
- (c) Fillets: available kinds, application and sources.
- (d) Colours and protective materials; classification of colours, pigments; shellac and its qualities.
- (e) Abrasives: types, grades, classification, manufacture and application.

2. Planning:

- (a) Interpretation of drawings, bill of materials, order of operation, sketching and full-size layout.
- (b) Machine allowance; signs and normal pattern allowances.
- (c) Draft; normal allowances on general pattern constructions, its application to simple patterns.
- (d) Contraction allowances; purpose of the allowance, introduction of the shrink rule allowances for cast iron and steel.
- (e) Simple core print forms; standard forms and dimensions.

3. Hand Tools:

Pattern-making hand tools for cutting, measuring, fastening, and assembling; use and care of tools; tool technique and sharpening.

4. Machine Tools:

- (a) Safety precautions, care and proper operation of machine tools.
- (b) Variety saw: ripping, cross-cutting, rabbetting tenon forms; use of ripping and cross-cutting saw blades.
- (c) Jointer: surfacing, edge jointing, glue jointing, taper planing.
- (d) Band saw: adjustment of machine and blades, layout for economical band sawing.
- (e) Grinder: grinding edge tools; tool angles for planing, cutting, and turning tools.
- (f) Wood grinder: grinding concave and convex surfaces, use of disc and spindle grinders, angular grinding for tapers and draft.
- (g) Jig saw: simple forms of cuts for scrolls and joints.
- (h) Lathe: turning between centres, simple face-plate work; preparing materials, setting up work; scraping and cutting tools; use of screw chuck.

5. Types of Constructions:

- (a) Solid and simple built patterns for bench including green and dry sand cores, vertical dry sand cores, attached core prints.
- (b) Turned solid patterns between centres, patterns with core prints for vertical and simple horizontal prints, simple split patterns for the lathe.
- (c) Combination of simple lathe and bench work with and without cores.
- (d) Forming simple type core boxes, square and round; testing; parted core boxes, use of dowel pins, core box proportions.

6. Foundry:

- (a) Moulding: simple moulding equipment; making two-part mould; procedure in making, ramming, simple venting, pattern removal, finishing, runners and gates, closing; green sand cores formed by pattern; use of simple type cored moulds.
- (b) Casting: preparation of metal, safety precautions, pouring; checking casting.

FARM MECHANICS

1. Drawing and Plan Reading:

Map drawings showing buildings, roads, fences, gates, streams, bridges, culverts, water-lines, tanks, drain tiles, soil areas, drainage direction, existing crops and orchards; working and assembly drawings; drawings of farm objects to include sections and scales.

2. Woodwork:

- (a) Tool sharpening: use of grindstone, emery wheel and oil-stone in sharpening common hand tools; practice in jointing, setting and filing hand saws.
- (b) Construction and repair: construction of two or more articles of use in the shop, in the home or about the farm, such as farm shop tool cabinet, nail and staple box, mitre box, folding bench, step-ladder, book-case, farm gate, poultry feed box, oat sprouter, or fattening crate.

3. Painting and Finishing:

Materials used in paints, shellac, and varnish, and meaning of terms, pigment, vehicle, thinner, drier; mixing paints and painting for specified conditions of exposure; methods of refinishing floors and furniture; whitewashes for farm use.

4. Forging and Metal Work:

- (a) Forging such articles as meat hook, rope cleat, chain link, cold chisel, and door-pull, to give a knowledge of forging and tempering; use of hack saw in cutting metal; use of the cold chisel and file in vise work with cold metal.
- (b) Soldering: preparation of soldering iron, selection of fluxes; soldering applied to needs of home and farm.
- (c) Drilling: use of post drill for drilling and countersinking; use of taps and dies.

5. Rope work: an extension of Grade IX work.

6. Farm Machinery:

- (a) Implements: types, uses, care and repair.
- (b) Motor mechanics: dismantle and assemble a four-stroke cycle and two-stroke cycle engine to learn the location, **names** and functions of the principal parts and events in the cycle; study automobile parts for an elementary knowledge of the clutch, brakes, transmission and electrical system; perform service jobs such as patching tubes, changing tires, lubricating and making up anti-freeze solutions.

COURSES OF STUDY

GRADE XI

Pupils enrolled in Grade XI are required to elect a particular shop in which to specialize if such choice has not been previously made.

Instruction in this elected shop is supplemented by instruction in a number of related shops, one of which must be drafting.

The time devoted to shop work may be distributed among the major and related shops according to the varying demands of industry for highly specialized workmen and the capacity of the school organization to meet the needs of the particular enrolment.

GRADE XI MAJOR COURSES

Aircraft Mechanics.....	page 27
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Applied Electricity.....	35
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AIRCRAFT MECHANICS

A. THEORY OF FLIGHT AND AERODYNAMICS .

1. Nomenclature.
2. Physical Laws: Newton's laws; pressure; work, power and energy; moments; vectors; relative motion.
3. The Atmosphere: physical properties of air; constituents; effects of temperature, pressure and humidity on density; thermometric scales.
4. Motion of Fluid: Bernoulli's theorem applied to airfoils; streamline flow, and development of wing from Venturi tube; pressure distribution (airfoils).
5. Airfoils: characteristics; wind tunnel tests; graphs; airfoil profiles and selection; aspect ratio; centre of pressure travel; lift and drag coefficients; performance calculations; high lift devices.

B. AIRCRAFT METAL WORK

1. Aircraft Metals (sheet and tubular) a study of the properties; alloying elements; methods of identification; general uses; and classification of steels.
2. Tools (hand): care, maintenance and practical use of; measuring; marking; cutting, driving; boring; threading and tapping; bumping and riveting tools; stakes and punches. (Machine): bending; grooving; rolling; and brake operations.
3. Fastenings: identification and the knowledge of special uses of various types of rivets (solid and tubular); screws (wood and metal); cowl fasteners; and standard locking devices.
4. Practical: practice in such operations as:
Laying out: types of joints and methods of fabrication; allowances for bending and joining.
Cutting; shaping; bending; drilling; punching; riveting; soldering (composition and use of flux); and simple heat treatment of metals and alloys; applied to: projects using single, double and quadruple shear, and dimple type joints; repairs to cowlings (dents, cracks, and holes); patches on oil tanks; construction of streamline cover plates, inspection covers, flanged projects, oil tanks, and various fittings.
5. Protective Coatings: metallic coatings and chemical treatments; cleaning; treatment of interior surfaces of metal tubing, and exposed and unexposed metal parts.
6. Welding:
 - (a) Precautions and safe practices in care and operation of equipment. Procedure for connecting equipment to tanks, and operation of valves and regulators. Design and function of blow pipes; flame control and adjustment.
 - (b) General principles of welding; expansion and contraction of metals; and principles of joint design.
 - (c) Practical: preparation of materials prior to welding processes; practice in simple free-hand and guided cuts; welding iron and steel; fusion welds in cast iron; bronze welds in steel and cast iron; tube welding; methods of testing; and analysis of failures.

C. AIRFRAME MECHANICS

1. Aviation:
 - (a) The airplane: its history and place in the world of today.
 - (b) Qualifications and responsibilities of those employed.
 - (c) Government supervision.
 - (d) General aeronautical terms.
 - (e) Types of aircraft.
2. Main Structural Units:
 - (a) Function of: fuselage, wings, empennage, and landing gear.
 - (b) Names and location of the component parts of each unit.

3. Materials:

- (a) Woods: species, characteristics, identification, seasoning, defects and selection factors.
- (b) Fabrics: function, characteristics and application.
- (c) Dopes and varnishes: storage, application, care and operation of equipment, safety precautions, fire hazards.
- (d) Wires, cables, fastenings: specifications.

4. Tools (practical):

- (a) Driving, marking, measuring, cutting, boring tools, gauges, surface plate and indicators: uses, limitation, care and maintenance.
- (b) Miscellaneous tools: as required for special purposes.
- (c) Grinding and honing edge tools.

5. Locking Devices and Fastenings (practical):

- (a) Wood: splicing, steaming and bending, and laminating (longerons, spars).
- (b) Fastening devices: types, functions.
- (c) Glue: kinds, specific use, preparation, application, clamping pressure.
- (d) Cable-splicing: wrapped and soldered splice, tucked splice: R.A.F. methods.

6. Fuselage (practical):

- (a) Types, trusses, component parts and functions, loads and stresses.
- (b) Fuselage fittings: engine-bearer, wing, rudder-post, longeron and strut; laying out, drilling, filing, bending (use of bending jig), riveting, welding.
- (c) Bulkheads: types, construction of a laminated type.

7. Wings (practical):

- (a) Component parts:
 - (1) Spars or beams: types, loads and stresses, wood species. Box-spar construction: selection of material, location and type of splice, ratio, laying out, fitting, glueing, testing. Assembling of members: flanges, bulkheads, webs.
 - (2) Ribs: types, loads and stresses, wood species, rib members, jig-work, laying out, selection of material, wood-bending methods, care in glueing and nailing, testing for design load, testing to destruction.
- (b) Function and construction of: compression struts or ribs, bracing wires, fittings, wing tips, and leading and trailing edges.

D. AVIATION ENGINES

1. Nomenclature and General Principles of the Internal Combustion Engine.
2. Review of the Four-stroke Cycle Engine; piston displacement; compression ratio; horse-power calculations; volumetric, mechanical, and thermal efficiency.

3. Engine Types: vertical (in-line); V (in-line); radial; description and classification.
 4. Materials, Construction and Function of Engine Units: cylinder assemblies; piston assemblies; connecting rods; crank-shaft and thrust bearings; main bearings; valves and valve-operating mechanisms; crank cases; in-take and exhaust manifolds; oil and water pumps; spark plugs.
 5. Tools: general purpose and special (engine type).
 6. Engine (in-line):
Top overhaul (use of manuals): dismantling; cleaning and inspection of units; cylinder inspection; valve grinding and checking; piston inspection and repair; fitting piston rings; piston pin inspection; camshaft and valve-operating mechanisms; inspection and repair; intake and exhaust manifold inspection; order of assembly; tappet adjustments; valve and ignition timing procedure; timing charts; safe-tying and locking devices.
 7. Cooling Principles and Systems.
 8. Lubrication: lubricating oils (laboratory tests); lubricant characteristics; elements and operation of the Dry-Sump pressure system equipped with automatic oil temperature control and electrical heating element.
 9. Fuels: classification; benzol, alcohol, gasoline; specifications and tests.
 10. Fuel Systems: tanks; gauges; pumps; strainers; primers; valves. Fuel system arrangements (gravity and pressure types).
 11. Carburetors: types; function of units; operation, maintenance and installation.
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AUTO MECHANICS

(See also Related Courses: **DRAFTING** for Auto Mechanics, p. 81; **ELECTRICITY** for Auto Mechanics, p. 86; **MACHINE SHOP PRACTICE** for Auto Mechanics, p. 86.)

To introduce trade work in the Grade XI course, automobiles to be admitted to provide for such work and operations as fall within the scope of this course.

1. Engine:
 - (a) General construction of typical multi-cylinder engine; cylinder and valve arrangements; types and materials of crankshaft, main bearings, pistons, piston pins, connecting-rods, valves; valve action details; valve timing.
 - (b) Engine lubrication; theory of lubrication; engine oil specifications; details of typical engine lubricating system.
 - (c) Engine power; factors of power; calculating engine horsepower; piston displacement; compression ratio; relative pressure.
 - (d) Common causes of abnormal engine noises.

2. Engine Service Operations, such as:

- (a) Checking engine cylinder compression.
- (b) Measuring cylinder wear.
- (c) Fitting connecting-rod bearings, piston pins, piston rings, checking connecting-rod alignment.
- (d) Reconditioning engine valves, valve seats; adjusting valve clearances.
- (e) Replacing water-hose connections.

3. Automotive Electrical Systems:

- (a) General outline of the various systems involved: starter, generator, lighting, and ignition; types, kinds and sizes of automotive electrical wires, cables and terminals.
- (b) Storage battery: general construction and operation of automotive type; testing and charging storage battery.
- (c) Starter system: location in circuit and purpose of units involved; general construction and operation of typical starter motor.
- (d) Generator system: location in circuit and purpose of units involved; general construction and operation of typical automobile generator.
- (e) Lighting system: purpose and location of various units involved; types and kinds of automotive lamp bulbs; adjusting headlamps; connecting electrical accessories; purpose and location of fuses.
- (f) Ignition system: purpose and location of various units involved in typical automobile ignition system; construction and types of spark plugs, cleaning and adjusting spark plugs; adjusting and setting ignition timing; installing and connecting distributor wires.

4. Fuel System and Carburetion:

- (a) Kinds of gasoline: high test, low test, high compression; octane rating.
- (b) Construction and operation of typical mechanical fuel pump.
- (c) Further study of principles and requirements of carburetor and simple adjustment.
- (d) Carburetor types and styles.
- (e) Cleaning fuel strainer and air cleaner.

5. Transmission Systems:

- (a) Various units involved and relationship to one another.
- (b) Clutch construction: dismantling, identifying and replacing defective parts, assembling and adjusting.
- (c) Gear-box construction and general principles of synchronized gear engagements: dismantling, identifying and replacing defective parts, assembling and adjusting.
- (d) Rear axle arrangements; types and applications; construction of typical rear axle unit; hypoid gears.

6. Steering Gear, Road Wheels and Brakes:

- (a) Types of front-wheel mountings; solid axle and independent wheel suspension.

- (b) Meaning and purpose of camber, caster, king-pin inclination, toe-in; making minor adjustments to wheel alignment.
- (c) Construction of two popular types of steering gear; adjusting steering gear and linkage.
- (d) Type of brakes; mechanical and hydraulic operation; general principle of hydraulic brake system; construction of two popular types of brake units; removing, replacing and adjusting typical brake-shoe assembly.

DRAFTING

(ARCHITECTURAL AND BUILDING CONSTRUCTION)

1. Building Construction Details:

- (a) Preparation of working details, involving the following elements singly or in combination:
 - (1) Foundations: slab, stepped, offset, plain and reinforced footings; post, pier, column, and wall foundations; foundation waterproofing.
 - (2) Frame wall construction: elements of balloon and braced frames; wood and masonry veneer coverings.
 - (3) Masonry wall construction: wall thicknesses; face and backing units; arch types and their geometrical layout.
 - (4) Wood floor construction: joist arrangement, fire-stops, bridging, girders, trimming, floors.
 - (5) Carpentry and joinery: joints, rough and finished carpentry, trim details.
 - (6) Windows: double-hung, casements in wood and metal; mullions, caulking; types for wood and masonry walls.
 - (7) Doors: construction, exterior and interior types and sizes, hardware.
 - (8) Fireplaces: hearth, throat, and flue construction; surround and mantel.
 - (9) Chimneys: flue types and sizes; wall sizes and materials, cleanouts.
 - (10) Stairs: types; open and closed-string construction; tread, riser, and hand-rail relation.
 - (11) Wood roof framing: elements of the flat, lean-to, hip, gable, gambrel, mansard types; dormers, coverings, cornices.
 - (12) Flashings: for hips, valleys, chimneys, cornices, parapets, soil pipes.
- (b) Layouts and working drawings: incorporation of the foregoing details in the working drawings for a kitchen equipment layout, summer cottage, or similar project.

2. Building Materials and Methods:

An elementary study of the materials of building construction and the local building by-laws and practices. This study to be carried on concurrently with the preparation of the details outlined in 1, above.

- (1) Wood: drying, shrinkage, defects, sawing, grading, measurement; properties and uses of various building woods.
- (2) Lime: properties; crushed and hydrated; mortar, plaster.
- (3) Portland cement: properties, uses in mortar, stucco, concrete.
- (4) Brick: varieties, uses, bonding types, joints, mortar.
- (5) Stone: classifications, properties and uses of granite, limestone, sandstone, marble, slate, shale; rubble, ashlar, veneers, bonding, waterproofing.
- (6) Concrete: proportions, mixing, placing, curing, forms, uses.
- (7) Gypsum products: properties of gypsum; use in plasters, boards, blocks, slabs.
- (8) Masonry units: concrete, cinder-concrete, silica, clay blocks.
- (9) Flooring: wood, concrete, terrazzo, mastic, tile, linoleum, cork, rubber coverings.
- (10) Glass: varieties, commercial standards, structural glass and block.
- (11) Paint: composition and uses of paints, enamels, varnishes, stains; paints for wood, metal, plaster, concrete.
- (12) Metals: properties and uses of iron, steel, copper, lead, zinc, tin.

3. Structural Design:

- (a) Elementary treatment of stresses in structures; tension, compression, shear, unit stress.
- (b) Bending moments and shear stress for uniformly distributed, concentrated, and cantilever loads; construction of bending moment and shear diagrams for the above.
- (c) Calculation of wood joist sizes for ordinary uniformly distributed loads; determination of maximum spans for commercial size joists in deflection; pier and footing sizes.

4. Perspective and Rendering:

- (a) General principles of perspective projection; determination of station point, picture plane, horizon, lines of heights, and vanishing points.
- (b) Problems in angular and parallel perspective applied to architectural details involving rectangular, triangular and pyramidal solids, curved lines and cylinders.
- (c) Rendering in pencil of simple forms in light and shade; rendering of simple architectural instrumental perspective in pencil.

5. History of Architecture and Design:

- (a) General outline of the history of ancient building, with emphasis on the Greek and Roman periods, particular attention to be given to the use of materials, methods of construction and to the form and proportion of details of these periods which are still in use.
- (b) Freehand sketches or formal drawings of representative details of the various periods.

DRAFTING (MECHANICAL)

1. Machine Parts:

Detail and assembly drawings of machine parts or mechanical equipment such as pulley transmission, tight and loose pulleys, safety collars, shafts and bearings, belt-shifting mechanisms, simple clutches.

- (a) Instruction regarding machining operations, tolerances, choice and purpose of materials used, pattern-making and moulding practice, shop terms.
- (b) Machine fastenings: selection of and correct specifications for machine screws, stud bolts, nuts, washers, taper pins, cotter pins, keys and keyseats, woodruff, feather and taper keys; national coarse and national fine threads; acme and square threads; right and left hand threads.
- (c) Machine fits: running, A.S.A. standard.
- (d) Quarter, half and revolved sections; broken views; auxiliary views.
- (e) Drawing of machine parts from notes and sketches prepared from measurements of actual objects; use of measuring instruments.
- (f) Inking, tracing and blueprinting.

2. Structural Steel:

- (a) Standard structural shapes—introduction to the structural steel handbook.
- (b) Lap and butt joints, types of rivets, bolts and welds.
- (c) Simple structural steel detail drawings, rivet symbols, pitch of rivets, dimensioning, gusset plates, base plates.
- (d) Bill of materials, calculation of lengths for rivets and bolts; preparation of rivet and bolt lists for shop and field work; paints and surface protection for structural steel.

3. Engineering Curves:

Drafting projects using such examples as parts of steam engine or internal combustion engine.

- (a) Practical geometrical layout for such curves as the ellipse, helix, and involute.
- (b) Plotting of curves for cams, uniform motion, harmonic motion, variable motion, quick return motion.
- (c) Applications of levers, cranks and cams in changing direction of motions; reversing mechanisms.

4. Development of Surfaces:

- (a) Triangulation method of development for objects such as transition pieces and irregular conical shapes.

5. Gearing:

- (a) Spur gears: tooth parts; plotting tooth curves by Odontograph tables and arcs of circles; drafting problems involving detail of pinion and spur gear; speed changing.
- (b) Bevel gears: right angle, acute angle and obtuse angle, top and bottom angles, pitch diameter; project of two gears in mesh to include tooth profile.
- (c) Worm and worm wheel: layout of worm threads, calculations for pitch and outside diameter, purpose of single, double and triple threads; drawing of worm and worm wheel.
- (d) Gear trains: spur, bevel, worm-gear trains; racks and pinions, speed-changing problems; calculation of the horsepower transmitted by spur and bevel gears using the Lewis formula.

6. Jigs and Fixtures:

A study of the uses of jigs and fixtures for performing machine operations; layout of a simple jig such as a drilling jig; applications of shop mathematics in determining angles, offsets and dimensioning.

(See also Related Course: **MACHINE SHOP PRACTICE** for Drafting, p. 88.)

APPLIED ELECTRICITY

(See also Related Courses: **DRAFTING** for Applied Electricity, p. 83; **MACHINE SHOP PRACTICE** for Applied Electricity, p. 90.)

A. INSTALLATION AND MAINTENANCE

1. Circuits:

- (a) The installation and study of more advanced work in electric services; non-metallic, metallic and rigid conduit circuits for light, heat and power.
- (b) Installation of D.C. and fractional A.C. motors using different types of starters and protective devices commonly used in industry.

2. Testing and Repair:

- (a) Testing and repair of circuits used in light, heat, and power, including D.C. motors, generators and industrial control equipment.
- (b) Stripping, securing winding data and rewinding one D.C. armature; making all necessary tests before, during, and after rewinding; truing-up commutator, undercutting mica, and complete final check-up before assembling for running test.

B. THEORY AND TEST

1. Electro-magnetism:

- (a) Application of Ohm's Law to the magnetic circuit to determine the relations between magnetomotive force, flux density and reluctance.
- (b) Development of magnetic circuit equations and plotting of magnetizing curves for cast iron, wrought iron and steel.

2. Insulation:
Properties of insulating materials such as rubber varnishes, plastic compounds, impregnated paper, varnished cloth, tapes, asbestos and silk.
 3. Resistors and Resistance Measurements:
 - (a) An examination and study of resistors used in industrial control apparatus for controlling motors and generators.
 - (b) Measurement of resistances connected in series or combinations of both; methods of determining the combined resistance.
 4. Induced Currents:
 - (a) The production of induced currents including the elementary laws of induction relating to direction of induced pressure.
 - (b) Development of E.M.F. equation for D.C. generators and motors.
 - (c) Building up D.C. generator voltage.
 - (d) Motor speed as related to field strength.
 5. D.C. Generators:
Operation and control of D.C. shunt, series and compound-wound generators to determine their characteristics.
 6. D.C. Motors:
Operation and control of D.C. shunt, series and compound-wound motors to determine their characteristics.
 7. Maintenance:
Tests used by journeymen in locating troubles in D.C. motors, generators and industrial control apparatus; methods of repair.
 8. Determination of efficiency characteristics of D.C. generators and motors based on actual laboratory tests.
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APPLIED ELECTRONICS

A. THEORY AND TEST

NOTE:—The order of presentation given below is not necessarily the required teaching order. Symbols, both electronic and radio, should be introduced as required in the course. Methods of establishing correct heater, anode and grid voltages should also be introduced as required. Items 2 and 3 below to be introduced incidentally in course as required.

1. Vacuum Tubes:
 - (a) The diode. Construction and testing of standard two element (diode) vacuum tube. Note effect of filament voltage change on plate circuit. Note effect of plate voltage change on plate current. Application of the diode as rectifier. Effect of load resistance on output.
 - (b) The triode. The control action of grid placed between filament and plate. Grid voltage, plate current and plate voltage, plate current characteristic curves. Information derived from curves with respect to voltage change, current change, use of tube as amplifier, gain. Simple circuits using tube, illustrating operation as an amplifier, grid bias rectifier and control device for relay operation to be constructed. Rectification by means of grid leak and condenser. Separate heater and cathode type tube and comparison with filament type.

2. Electrostatics: Formation of electrical charges, their attraction and repulsion. Composition of electrical charges, the electron theory and its application to static charges. Charging by induction, distribution of charges on material, stress lines between charged bodies, discharge from points compared to spheres. Electrostatic screening. Storage of charge as in condenser and controlled liberation of charge by resistor across condenser.
3. Electron Theory and Thermionic Emission: More detailed consideration of flow of electrons in a body acting under electrical pressure. Effect of heat on liberation of electrons. Electron-emitting materials. Electron emission in vacuum, space charge. Edison experiment to note presence of free electrons in a vacuum (introduction to diode).
4. Alternating Current (qualitative considerations only to be taken under this heading):
 - (a) Alternating current generator, the sine wave, cycle, frequency, position in the frequency spectrum, amplitude.
 - (b) The telephone—transmitter and receiver—conversion of sound to alternating current.
 - (c) The induction coil and principles of induced currents with varying D.C. voltage.
 - (d) The transformer, showing application of induced currents to conditions in an alternating current circuit. Effect of voltage ratio, turns ratio, current ratio with application in power transformer.
 - (e) The condenser, its operation and application, the factors affecting capacity of the condenser in filtering and by-passing. Reactance change with frequency.
 - (f) The coil—operation and application in circuit. Self and mutual inductance. How non-inductive coils are wound, and reason for using. Coil use in chokes, filters.
 - (g) Coil and condenser combined—resonance effect—application in tuning.
5. Circuit Elements: Typical circuits such as amplifier circuits, control devices, as used in electronic devices—combining alternating current theory and vacuum tube theory.
 - (a) Amplifier types—low frequency—transformer and resistance coupled, push-pull type.
 - (b) Amplifier—high frequency—the use of tuned grid and tuned plate circuits and gain obtained thereby. Precautions needed to avoid undesirable feedback.
 - (c) Comparison of amplifier types—frequency response curves, factors affecting frequency response. Extra amplifiers mentioned here—choke coupled, direct coupled.
 - (d) Use of series and cathode resistors and by-pass condensers in vacuum tube plate circuits.
 - (e) Tone control circuits—to reduce high frequency and low frequency content.

- (f) Volume control circuits—location in circuit, taper to use, carbon versus wirewound controls.
 - (g) Rectifier types—half-wave, full wave for vacuum tube and dry disc types.
 - (h) Filter circuits—choke input, condenser input and characteristics of each type.
 - (i) Control circuits—typical circuits to illustrate the application of vacuum tube triode to electronic control.
6. Oscillation: Production and control of oscillator frequency and output in triode tubes. Application in test oscillator. General considerations of oscillations in electronic circuits—noting cause of undesirable feedback both regenerative and degenerative.
 7. Test Equipment: Elementary—simple A.C. and D.C. meter movements, ohmmeter, multimeter, tube tester, test oscillators, construction and principles of operation of each tube. Application in servicing electronic equipment—fundamental principles of organized test procedure in locating faults.

B. SHOP COURSE

1. Bench Work—to be introduced as required: use of electrical soldering iron; shaping, cutting, drilling light metal chassis; tapping; typical fastening devices, screws, lugs, terminal strips used in electronic work; hardware.
2. The Colour Code: for condensers, resistors, coils, transformers, to be introduced as required.
3. Construction and use of simple series and shunt-type ohmmeters.
4. Construction and test of simple half and full wave rectifier circuits. Tests to include those for short and open circuits and tests under no-load and load condition.
5. Construction and use of simple condenser tester.
6. Construction and use of simple tube tester.
7. Construction and test of two-stage transformer coupled telephone amplifier. Checks to be made with ohmmeter and voltmeter.
8. Construction and test of two-stage resistance coupled amplifier. Checks to be made with ohmmeter and voltmeter.
9. The addition of simple volume and tone controls to an amplifier.
10. Construction and test of simple A.C. output meter.
11. Construction and test of simple vacuum tube voltmeter.
12. Construction of a simple relay and insertion in amplifier circuit to illustrate use as a control device.
13. Construction of simple audio oscillator and test of same for output.
14. Construction of a radio frequency amplifier.

NOTES:—(1) The tube base numbering system should be introduced incidentally in the course as required.

(2) The projects given above should be introduced at the appropriate time to suit the theory and test course given.

MACHINE SHOP PRACTICE

1. Hand Tools and Bench Work:

- (a) Chipping: cast iron and steel, various chisels and their uses.
- (b) Filing and scraping: a flat surface; irregular forms requiring a variety of shapes and cuts of files.
- (c) Reaming: parallel and taper holes.

2. Layout Work:

Use of precision measuring instruments such as protractor, thread and micrometer gauges, surface plate and surface gauge.

3. Machine Operations:

- (a) Lathe: shifting a centre, truing a damaged centre, aligning centres; freehand turning; cutting right and left hand national standard threads, and square threads; face-plate work, independent chuck work; taper turning and fitting to gauges; setting a gear-change lathe; steady and follow rest applications.
- (b) Drill press: clamping of irregularly shaped work and practice in drilling and countersinking in various metals; counterboring; reaming; use of drilling jigs; boring bar and flycutter.
- (c) Shaper: dovetail cutting, internal and external; machining of irregular surfaces; internal keyseating.
- (d) Miller: setting up and care and operation of machine; methods of setting up and securing work; plain and side milling; sawing and slitting; use of form cutters and flycutters; direct and plain indexing and plain milling of squares and hexagons.
- (e) Grinder:
 - (1) Practice in grinding tools and drills of various forms and sizes.
 - (2) Surface grinder: securing work, adjusting feed and stroke, dressing wheel; surface grinding.
 - (3) Portable grinder: grinding lathe centres; external grinding in the lathe.

4. Metallurgical Work:

Ferrous and non-ferrous metals in common use, alloys of same; theory of and practice in hardening, tempering and annealing; classification of metals, spark test; hardness test (file).

5. Materials and Calculations:

A study of trade-names, processes, stock materials and sizes, approximate costs and markets; applications of mathematical principles such as gear ratio, feeds and speeds, and tapers and index calculations.

6. Welding and Brazing:

Oxy-acetylene method: the torch, lighting the torch; neutral, reducing and carburizing flames; manipulation of torch for welding and brazing; fluxes; testing joints.

MINING

A. GEOLOGY

1. General:

Geological maps, age of rocks, geological history.

2. General History of the Earth:

A very brief outline of the geological history of the earth with mention of the following eras: Pre-Cambrian, Cambrian, Ordovician, Silurian, Devonian, Carboniferous, Permian, Triassic, Jurassic, Cretaceous, Tertiary, Quaternary.

3. Pre-Cambrian Geology:

A detailed study of the geological processes involved and the rocks produced in the following periods: Keewatin, Grenville, Laurentian, Temiskaming, Algoman, Cobalt, and Keweenawan.

4. Igneous Activity:

- (a) Causes of liquefaction of rocks.
- (b) Nature of igneous magmas.
- (c) Crystallization of igneous magmas.
- (d) Causes of igneous intrusion.
- (e) Contact metamorphism.

5. Mineral Deposits:

- (a) Veins:—simple or fissure; composite or lode; compound veins; contact veins; blind veins; stock work; pipes or chimneys; branching veins; overlapping veins.
- (b) General features of veins:—location; small displacement, small outcrops; vein systems; termination; influence of country rock.
- (c) Other forms of mineral deposits:—beds, masses; magmatic segregations; pegmatites.
- (d) General features of mineral deposits: ore shoots; rock association of mineral deposits; alteration by mineral deposits; formation of minerals.

B. MINING

1. Introduction:

- (a) Relationship between search for metals and the spread of civilization.
- (b) Relation between the production of metals and the wealth of a country.
- (c) Mining as an industry.
- (d) Classification of ore bodies.

2. Prospecting:

Surface indications of ore bodies:—veins; capping and stains; float; topographic features; magnetic attraction; rock association of minerals; electrical properties of minerals.

3. Staking Claims:

Conditions for staking; Ontario Department of Mines; mining divisions; miner's license; land open for staking; lands not open for staking; forest reserves; lands under timber license; prohibition of mining work; surveyed and unsurveyed lands; mining claims in unsurveyed lands; mining claims in surveyed lands; posts; witness posts; irregular areas and land covered by water; number of claims to be staked.

4. Recording and Patenting:

Application to record; affixing metal tags; disputing application; certificate of record; rights of licensee; assessment work; computation of time extension; abandonment; forfeiture; inspection of claims; surface rights compensation; issue of patent for mining claim.

5. Disposal of Mining Properties:

Outright sale, options, lease.

6. Exploration of Mineral Deposits:

- (a) Surface exploration by stripping, test pits, trenching and sampling.
- (b) Underground exploration by diamond drilling, exploration shafts and drifts.

C. FIRE ASSAYING

1. General:

General methods of assay; fluxes; chemical reactions in fluxing; common assay fluxes; uses of litharge in assaying; fusion products; assay weights.

2. Steps in Assaying:

Fusion; cupellation; parting; annealing; weighing; inquartation.

3. Types of Ores Assayed:

- (a) Assay of ore with acid gangue.
- (b) Assay of ore with basic gangue.
- (c) Assay of ore with half acid and half basic gangue.
- (d) Assay of reducing ores:—iron nail assay; litharge nitre assay; roasting method; scorification assay.

4. Combination Wet and Fire Assay:

- (a) Assay of solutions by evaporation; lead boat, evaporation with litharge.
- (b) Assay of solutions by precipitation; by zinc and lead acetate; as sulphide; by cement copper; by silver nitrate, by copper salt.

D. METALLURGY

1. General:

Definition, history, ore types, general methods of extracting metals from ores.

2. Metallurgy of Iron and Steel:

- (a) Forms in which iron is used; iron ores.

- (b) The iron blast furnace, hot blast, blowing in, operation, products, chemistry of process, quality of pig iron, regulation of blast furnace.
- (c) Production of wrought iron; carburization of wrought iron.
- (d) Manufacture of steel; cementation process, crucible process, Bessemer process acid and basic.
- (e) Processing:—electric super-refining, making ingot, heat treatment, case hardening, tempering, annealing, normalizing.

3. Metallurgy of Copper:

- (a) General:—ores of copper, grades of copper ore, Canadian copper.
- (b) Concentration:—selective flotation.
- (c) Roasting:—multiple hearth furnace, sintering machines, chemistry.
- (d) Reverberatory furnace smelting:—construction of reverberatory, operation, chemistry, nature and disposal of products.
- (e) Blast furnace smelting:—construction of blast furnace, nature of feed, operation, chemistry of process, nature and disposal of products.
- (f) Converting:—construction of converter, operation, chemistry of process, nature and disposal of products.
- (g) Refining of blister copper:—electrolytic refining, chemistry of process, by-products.

E. CHEMISTRY

1. Preparation of Reagents:

Review of kinds of chemical change, acids, bases, and salts, solubilities of classes of metal compounds, preparation of molar, normal solutions and solutions of special strengths.

2. Analytical Chemistry:

- (a) Dividing the common metals into groups by the use of standard reagents.
- (b) Silver group:—general experiments to show properties of silver group metals, analysis of silver group, description, occurrence, uses and compounds of silver, lead, mercurous mercury.
- (c) Copper-tin group:—experiments to show properties of metals of copper-tin group, separation of tin group metals from copper group metals, analysis of copper group, description, occurrences, uses and compounds of copper, bismuth and cadmium.
- (d) Iron-aluminum group:—experiments to show properties of metals of iron-aluminum group, precipitation and separation of iron and aluminum groups, analysis of aluminum group, description, occurrence, uses and compounds of aluminum, chromium, and zinc, analysis of iron group, description, occurrence, uses and compounds of iron, cobalt, nickel, manganese.

3. General Qualitative Analysis:

- (a) General methods of preparing solutions from mineral samples.
- (b) Analysis of solutions containing one or more of the common metals.

F. SURVEYING AND MAPPING

1. Measurements of Level and Horizontal Lines:
 - (a) Instruments used:—chains, tapes and reels, rods, pins, range poles.
 - (b) Methods:—ranging a line, doing up and undoing the chain and tape, measuring on level ground, measuring on slopes.
2. Measuring Differences of Altitude or Levelling:
 - (a) Instruments:—construction of the level, levelling rods.
 - (b) Use of the level:—adjustment, setting up, differential levelling; profile levelling.
3. Determination of Direction and Measurement of Angles:
 - (a) Compass:—adjustments, use.
 - (b) The transit:—construction and care.
 - (c) Use of the transit:—carrying the transit, setting up the transit, to measure an angle with the transit.
4. Traversing:

A simple traverse with chain and transit with details by offsets, survey notes.
5. Mapping:
 - (a) Plotting of various surveys by rule and protractor.
 - (b) Finding irregular areas by planimeter.

PRINTING

(See also Related Course: **ART** for Printing, p. 78.)

1. Study of Materials:
 - (a) Type faces: classification into basic groups—text, Roman, Italic, Gothic or sans serif, script or cursive; a comparative study of available faces in shop, identifying characteristics.
 - (b) Roman sub-divided into old style, modern, transitional, antique.
 - (c) Type sizes: application of point system, fontage, alignment, shoulder depth.
 - (d) Type series: analysis of possibilities for variety without mixing; small caps and italics.
 - (e) Type families: development from original face—bolder, lighter, condensed, extended; unity with variety, effects of development on beauty and legibility.
 - (f) Letter-spacing: examination of typical faces for proper letter-spacing.
 - (g) Rules, borders, ornaments: brass, machine, foundry; trade practices as to body sizes, fontage, purpose, use, dangers.
 - (h) Paper: history, sources of materials, processes, kinds, uses.
 - (i) Inks: kinds, materials, manufacture; fitness for use as to paper, press.
 - (j) Engravings: line, Ben Day, halftone, wood, wax, and lino.
 - (k) Plates: electro, stereo and rubber.

2. Planning a Job:

A thorough study of the steps in planning any piece of job-printing or advertising—analysis of copy, choosing important or salient points, making sketches and making a complete layout.

3. Job Composition:

A number of jobs to be developed as above, set, proofed, read, corrected, and proofed again. These jobs to consist of many types of business forms and advertising including school printing. Jobs designed and planned in the related art classes to be completed in the print shop wherever possible.

4. Press Work:

(a) The platen press:

- (1) Feeding: placing stock, fanning out, picking up, placing, removing; cleanliness, safety; causes of faulty work; slip-sheeting.
- (2) Care of press: oiling, inking, operating, setting up, cleaning up.
- (3) Lock-up: materials, uses, positions, procedure.
- (4) Putting job on press: reading order, preparing press, putting form on, precautions, make-ready, checking, O.K.

(b) Progressive acquaintance with, and experience on any other types of press available.

NOTE:—In schools where there is a fully equipped pressman in charge, a more comprehensive course in press-work is advisable.

SHEET METAL

(See also Related Course: **DRAFTING** for Sheet Metal, p. 85.)

1. Pattern Development:

- (a) Parallel line development: two and three-piece round and rectangular elbows; ordinary tees and Y-branches; simple eavestrough and coping mitres; scoops, scalepans and register boxes.
- (b) Radial line development: conical-shaped articles such as funnels, flaring pans, pitched covers and tapering pails or measures.
- (c) Triangulation method of development: irregular shapes such as rectangular flaring pans; simple transition fittings such as square to rounds or ovals.

NOTE:—All patterns developed to be fabricated in metal to actual size.

2. Seams and Seaming Allowances:

Various types and uses of such seams as standing, double, grooved, Pittsburgh, riveted and lined; the amount of metal required to make each seam; common uses and advantages of each in fabrication and installation.

3. Hand Tool Operations:

- (a) Soldering: forging soldering irons to shapes for various uses; soldering metals such as stainless steel, copper, zinc and lead.
- (b) Tinner's snips: use of various types such as straight, curved, double-cutting and scroll snips; care and sharpening of cutting blades.

4. Machine Operations:

- (a) Adjustable bar folder: adjusting folder for tension on various gauges of metals; width and types of folds.
- (b) Bending brake: adjusting for tension and bending on various gauges of metals; using forming attachments for making coves and ogees.
- (c) Roll former: adjusting and operating in forming cylindrical, flared and wired objects.
- (d) Burring machine: burring flat discs and cylindrical shapes for seaming.
- (e) Turning: turning edges of cylindrical and conical-shaped objects for wiring.
- (f) Wiring machine: wiring straight and formed edges.
- (g) Beading and crimping: for ornamenting, reinforcing and reducing cylindrical and conical-shaped objects.

WELDING

(OXY-ACETYLENE AND ELECTRIC)

A. OXY-ACETYLENE WELDING

1. Advanced Welding Techniques:

- (a) Controlling warping and buckling in sheet iron welding—tack welding.
- (b) Use of clamps and special fixtures.
- (c) Making non-rigid butt joints in welding sheet iron.
- (d) Preparing edges of heavy plates for welding; use of standard joints in plate welds, introduction back-hand method.
- (e) Selection of rod sizes for various plate thicknesses.
- (f) Various shop tests for welds; homogeneity and free-bend tests.
- (g) Vertical welding.
- (h) Spark tests for steels.
- (i) Pre-heating for cast iron welding—use of gas and air torches.
- (j) Brazing cast iron.

2. Weldability of Metals:

Welding rods for steels (low and high carbon), brass, and aluminum.
Welding procedures for cast iron, brass, bronze and aluminum.

3. Regulators and Torches:

Instruction in regulator and torch repairs confined principally to cleaning, and replacing valve seats and diaphragms.

4. Heat Treatment of Steel:

- (a) Annealing, normalizing, hardening and tempering as applied to welding practice.
- (b) Forge practice—pre-heating, bending and shaping as an aid to welding.

B. ELECTRIC ARC WELDING

1. Electrodes:

- (a) Sizes, composition and uses of electrodes (bare and coated).
- (b) Determination of polarity by burn-off rate.
- (c) Movements: effects of various weaving movements, arc length, current and rate of deposit.

2. Preparation of Work for Welding:

- (a) Cleanliness.
- (b) Provision for expansion and contraction.
- (c) Set-up of parts; tack welding.

3. Welding Operations:

- (a) Depositing filler metal.
- (b) Using chipping hammer and wire brush in cleaning operations.
- (c) Making fillet welds (single pass and multiple pass) on tee and inside corner joints; use of welder's templet.
- (d) Making standard welds on $\frac{1}{4}$ -inch and $\frac{1}{2}$ -inch steel plate.
- (e) Tack welding and other devices for the control of expansion and contraction of metals.

WOODWORKING—CABINET-MAKING

The Grade X course to be extended to include cabinet fitting and assembling and more advanced work on the machines and wood finishing.

1. Materials:

- (a) Glues: casein and vegetable.
- (b) Upholstery webbing, burlap, tow, moss sateen.

2. Hand Tool Operations:

- (a) The adaptation of various joints to particular types of work; the use and sharpening of hand cabinet scrapers and the scraper plane; setting, jointing and filing saws (hand and machine); forms for clamping irregularly shaped stock; final cleaning up of assembled stock before applying finish.
- (b) Bill of material: taken from simple furniture drawings.

3. Machine Tools and Operations:

- (a) Cut-off saw: construction of machine, function of parts.
- (b) Variety saw: construction; use of jigs, set up for cutting a stop groove or dado.
- (c) Jointer: adjustment of tables; cutting tapers; use of stops or jigs.
- (d) Shaper: set up; shaping against the collar; use of fulcrum pin; use of yoke (straight board) guide; adjustment of hold down and guards.
- (e) Band saw: adjustment; sharpening.
- (f) Grinder: selection and care (dressing); grinding wheels.
- (g) Sander: construction and use of discs, drums and belts.
- (h) Safety precautions: great care to be exercised in stressing the use of proper speeds and feeds, and adjustment of guards; special guards to be used wherever necessary.

4. Upholstery:

Slip-seat construction; use of webbing; webbing stretcher, tow or moss regulator.

5. Finishing:

- (a) Sponging work: preparation and application of water, acid, oil and spirit stains.
- (b) Use of pumice and rotten stone in water and oil rubbing; rubbing with brilliantine (combination of pumice and rotten stone in oil).
- (c) Application of polish and spiriting off.

WOODWORKING—CARPENTRY

(See also Related Course: **DRAFTING** for Carpentry, p. 82.)

Where feasible a small structure or sections of structure should be erected to include the structural members suggested in the course. Reading and interpreting plans and specifications and taking off quantities of materials to be emphasized.

1. Bench Work:

- (a) The pupil to be instructed in the use of such hand tools as the stair-maker's dado saw, router plane, level, draw knife, straight-edge and chalk-line. Construction of a small-scale model of a simple straight open stringer and of a straight closed stringer stair.
- (b) Framing square: laying out of common, hip and valley rafters; allowance for ridge board.

2. Constructions:

- (a) Foundations: excavating, wall and footing forms; setting forms in position, separating to obtain wall thickness; basement drainage, basement windows and doors; supporting piers; levelling basement floor.

- (b) Flooring: setting and levelling sill plates, built-up girders, joists, headers; bridging, stair openings (wells), sub-flooring (straight and diagonal laying).
 - (c) Frames: floor plate, studding, top plate, partition plates and studding, door and window openings; outside and inside sheathing; types and methods of laying commercial insulation; furring, wood and metal lath; the purpose and method of laying building paper on outside wall.
 - (d) Siding: cove (novelty, drop), bevel (clap-board), tongue and groove, V-match, composition (asphalt) siding.
 - (e) Trim: door and window frames; cornice trim; soffit, fascia, frieze, bed mould.
 - (f) Roofing: gable and hip type; roof sheathing; setting purlins and collar ties.
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WOODWORKING—PATTERN-MAKING

(See also Related Course: **MACHINE SHOP PRACTICE** for Pattern-making, p. 91.)

1. Study of Materials:

- (a) Pattern lumber: selection, defects, seasoning, grading disposition for strength and resistance to atmospheric changes.
- (b) Special pattern requisites: rapping plates, metal dowels, pattern letters, drawing straps, lifting screws.

2. Planning:

- (a) Preparation of orders of procedure, sketching and full-size pattern layout including cores and machine allowances.
- (b) Machine allowance, for ferrous and non-ferrous metals.
- (c) Principles of contraction and shrinkage in castings, making and design of shrink rules.
- (d) Pattern draft., determination of draft allowances in relation to the casting design; draft as it effects the machining of castings.

3. Hand Tools:

Extension of tool technique; use of higher precision measuring and checking tools such as core box planes, bent shank chisels and gouges, surface gauges, depth gauges.

4. Machine Tools:

Safety rules; lubrication, sharpening, setting and adjusting cutters and blades; use of jigs and holding devices.

5. Types of Constructions:

- (a) Patterns with horizontal cores, core print allowances for clearance and overhanging anchorage, attaching core prints.
- (b) Use of tail prints and core boxes.
- (c) Parted patterns for bench and lathe; use of dogs, fasteners and plates; combination of bench and lathe constructions; using core prints to strengthen constructions; proportioning core boxes.

- (d) Simpler type frame and box constructions in pattern and core boxes.
- (e) Introducing loose piece features in pattern and core box design; attaching with loose dowels and joints.
- (f) Face-plate turning, use of supplementary face-plates, attaching devices, toolcuts and positions; design and use of templates; application and layout of turned interior forms; measuring devices, rechucking, cutting speeds.
- (g) Use of cup chucks and screw chucks in turning shell patterns.

6. Foundry:

- (a) Moulding flasks, snap flasks, three-part flasks; use of cheeks and bars in flasks.
- (b) Types and positions of runners, risers, vents, gaggers and core irons.
- (c) Making three-part moulds, irregular partings, and cored moulds.
- (d) Core-making: sand and proportions, bonds; baking and inserting cores.

FARM MECHANICS

1. Drawing and Plan Reading:

- (a) Drawing to scale of rural maps and landscapes showing details.
- (b) Scale-drawing and blueprint reading of plans and elevations to include section and assembly drawings of various types of farm buildings; concrete form work.

2. Woodwork:

- (a) Tool sharpening: types of finishing stones and files for sharpening tools and implement cutters such as axes, hoes, cultivator points, binder and mower knives; jointing, setting and filing hand and circular saws.
- (b) Construction and repair:
 - (1) The work of Grade X extended to include more advanced woodwork used in framing construction such as a pinned mortise and tenon joint and a bolted spliced joint.
 - (2) Simple frame construction involving the use of the framing square.

3. Painting and Finishing:

- (a) More advanced knowledge of grades of paints and their application to farm buildings and equipment.
- (b) The use of stains, fillers, shellac, varnish, pumice and rotten stone, rubbers and polishes; methods of refinishing floors and furniture.

4. Forge and Sheet Metal:

- (a) Bending, shaping, welding and tempering operations used in making typical farm articles such as a clevis, hook, hinge, link, and in pointing harrow teeth.
- (b) Constructing and repairing simple sheet-metal objects.

5. Farm Implements:

- (a) A knowledge of the construction and theory of operation of various types of farm machinery such as binders, pumps, windmills, and engines.
- (b) Value of proper housing.
- (c) Grades and proper use of lubricants.
- (d) Repairs such as replacing guards on cutter bars, sections in blades, adjusting binder knotters, replacing slats and straps on binder canvases.

6. Concrete Work:

- (a) Proportions and methods of mixing.
- (b) Construction of wood and metal forms.
- (c) Selecting, testing and mixing aggregates.

7. Pipe Work:

- (a) Cutting, threading, fitting and assembling pipe.
- (b) Installation and maintenance of valves and fittings.

8. Motor Mechanics:

Prepared units and models to be set up for practice operations. Typical service adjustments similar to those suggested here to be planned around the available equipment.

- (a) Engine: removing and replacing gaskets, pistons, connecting-rod assemblies; adjusting valves; examining cylinders, pistons, pins and rings for wear; a study of piston travel, compression and displacement.
- (b) Electrical system: operation, care and minor service jobs involving battery, generator, starter, ignition and lights.
- (c) Carburetion: principles of carburetion; simple service jobs involving cleaning and adjustment.
- (d) Transmission system: dismantling and assembling clutch, gear box, universal, front and rear axle, springs and wheels.
- (e) Steering and brakes: examination of a typical steering linkage and assembly; types of braking systems, mechanical and hydraulic; adjusting two types of brake shoes.
- (f) Traffic regulations: a study of important rules and regulations of the Ontario Traffic Act.

COURSES OF STUDY

GRADE XII

Pupils enrolled in Grade XII are expected to continue their courses on the specialization plan as set up for Grade XI.

GRADE XII MAJOR COURSES

Aircraft Mechanics.....	page 51
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Drafting, Architectural and Building Construction.....	56
Drafting, Mechanical.....	58
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Machine Shop Practice.....	65
Mining.....	66
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Woodworking—Cabinet-making.....	74
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Woodworking—Pattern-making.....	76
Farm Mechanics.....	77

AIRCRAFT MECHANICS

A. THEORY OF FLIGHT AND AERODYNAMICS

1. Parasite Drag: skin friction; form drag; slipstream effect; determination of parasite drag caused by structural units, by equivalent flat plate area.
2. Propellers: fixed, adjustable, and controllable pitch; advantages; blade element theory; blade reactions; computation of blade angles; thrust and torque; efficiency; factors affecting selection.
3. Performance: calculations for straight level flight at sea-level, and at altitude; climbing; gliding; turns; spins; power required; factors affecting performance.
4. Stability: static and dynamic; axes of an airplane; factors influencing longitudinal, lateral and directional stability; angle of attack versus angle of incidence; relative wind; equilibrium in climb, glide and dive.
5. Control surfaces: types; longitudinal, lateral and directional control; design of control surfaces.
6. Loads and Load Factors: aerodynamic.

B. AIRCRAFT METAL WORK

1. Review of Aircraft Metals: Grade XI, detailed study.

2. Power Tools: care, maintenance and operation of; bench riveters; hand riveters; portable grinders; pneumatic wrenches; drills; and surfaces.
3. Practical: further study and practice in the heat treatment of metals; design of metal parts and fittings; shaping, tube bending; bumping and hammering of metal forms, cowlings, fairings, speed rings and streamline forms.
Jig construction and fabrication applied to such units as: ailerons, fins, rudder, stabilizer and flaps.
4. Welding:
 - (a) Review of: care, maintenance and use of equipment. Further practice in welding aircraft tubing and attachments.
 - (b) Aluminum and aluminum alloys: characteristics; joint design and preparation of material; welding technique; practice in butt welds with pure aluminum and aluminum alloy welding rods.
 - (c) Repairs on steel tube structures: type of joints used and methods of removing and replacing damaged sections; standard methods of reinforcing members.
5. Further Testing and Analysis of Structural Failures.

C. AIRFRAME MECHANICS

1. Materials: it is suggested that the study of materials not covered in Grade XI be completed and applied to the following topics.
2. Lofting:
 - (a) Select suitable type.
 - (b) Full-size layout of the main structural units and their component parts to detail: fuselage, wing and ailerons, stabilizer and elevators, fin and rudder. The work on each unit to be assigned to a suitable sized group.
 - (c) Construction of parts: assignment of work to groups. Make use of parts made in Grade XI wherever possible.
3. Assembling and Aligning:
 - (a) Fuselage:
 - (1) Necessity of jigs, proper sequence of steps as determined by type, careful placement of parts (avoiding undue stress), approximate attitude of members—obtained by use of trammel rod.
 - (2) Alignment: methods determined by type, organized routing of operations essential, tension of wires of greatest importance, specific and symmetrical tests, inspection and locking. Stress importance of accuracy.
 - (3) Coverings: fabric, plywood, metal; methods of application.
 - (b) Wing:
 - (1) Assembling: proper sequence of steps as determined by type. Example of a common type: spars, ribs, compression struts and fittings, root rib and fittings, leading and trailing edges, wing tip, nose form ribs, and aileron fittings.

- (2) Alignment: practice on each of three types: square, tapered, and sweep-back. Methods of locating reference points, use of trammels, tension of wires, effects of initial strain. Essential tests, inspection and locking.
- (3) Coverings: fabric, plywood, metal: methods of application

4. Assembling and Aligning the Complete Airplane:

- (a) Basic principles: study of data on angles and measurements relative to type, effects of warped surfaces and members out of alignment, special tools, and rigging allowances.
- (b) Order of assembly and alignment (fuselage in rigging position), landing gear, wings, horizontal stabilizer, vertical stabilizer, ailerons, elevators and rudder, inspection of control mechanism and attachment of control actuating units, adjustment of controls.
- (c) Symmetrical tests, inspection and locking.
- (d) Methods applicable to the assembling and aligning of other types.

NOTE:—Stress accuracy and care in handling.

5. Performance:

- (a) Control systems: study of three common types; operation and adjustments.
- (b) Weight and balance: methods of obtaining the location of the centre of gravity.
- (c) Unstable conditions: analysis of causes, and corrections.

6. Inspection:

- (a) Necessity for organized routing.
- (b) Daily, periodic, and special inspection.
- (c) Inspection following an accident.
- (d) Maintenance inspection record.
- (e) Airplane flight report.

7. Hydraulic Systems:

- (a) Advantages.
- (b) Hydraulically operated components on modern aircraft.
- (c) Simple hydraulic system.
- (d) Outline of typical maintenance routine.

8. Instruments:

- (a) Engine performance, aircraft performance, navigational instruments and their functions.
- (b) Installation, operation and maintenance.
- (c) Inspection: daily, preflight, periodic.
- (d) Compass: compensation, deviation (causes and effects), and testing.
- (e) Testing and adjusting: air-speed indicator, and altimeter.
- (f) Adjustments, minor repairs.
- (g) Line inspection and maintenance.

D. AVIATION ENGINES

1. Engine (in-line and radial):

Major overhaul (manuals and special tools): dismantling procedure; cleaning; inspection of parts for defects (magniflux); inspection of parts for wear; grinding and honing cylinder barrels; grinding valves and valve seats; crank-shaft and connecting rods—testing for alignment.

Assembling: summary of clearances and fits; fitting and adjusting, or replacement of main and thrust bearings, crank-shaft, cam-shaft, connecting rods, pistons, piston rings, valves and valve-operating mechanisms, valve timing (specifications).

2. Accessories: installation of carburetor; magnetos (dual system); generators and starters; control mechanisms—types and operation; ignition timing (specifications and charts); fuel and oil line inspection; fuel system installation (supercharged and non-supercharged); exhaust system—types and installation.
3. Performance: tests; connecting and checking instruments; trouble shooting; engine operation troubles—routine testing.
4. Propellers: classification; operation; inspection; repair; installation; and checking.
5. Carburetion and Supercharging:
Carburetors: principles and function; induction systems; fuel injection system; function, operation and adjustment of units.
Superchargers: types; functions; principles of operation and installation. Engine modifications.

E. STARTING, CHARGING AND ELECTRICAL SYSTEMS

NOTE:—To be correlated with Theory of Applied Electricity.

1. Starters: types; description; operation; adjustments; circuits; and installation of—direct electric and electric inertia starters (direct and remote control), and hand inertia starters.
2. Battery Charging System: function; circuits; units; and operation.
Generators: construction, classification and operating principles of electric generators.
Voltage regulators; current limiter; cutout field switch; voltmeter; ammeter; master switch.
Batteries: construction; maintenance; testing; and sources of trouble.
3. Ignition: battery and magneto systems (single and dual): functions.
Magneto (standard R.A. and R.F. types)—source of energy; elements and their functions; electrical operation; dismantling; testing, inspecting and repair of units; assembling; and testing methods.
Timing: staggered, synchronized and compensated; procedure (timing disc, firing order, sequence of operations).
Generators: function of component parts; armature rewinding and testing; commutators: repairing and testing.
4. Spark Plugs: component parts; testing; adjusting; ignition wiring and shielding (high tension, low tension); insulating materials.
5. Electrical Installation of: radio; instruments; and lighting circuits; bonding and uses of various types of fastening devices; testing new and old installations; location and causes of common failures in circuits.

AUTO MECHANICS

(See also Related Courses: **DRAFTING** for Auto Mechanics, p. 81; **ELECTRICITY** for Auto Mechanics, p. 86; **MACHINE SHOP PRACTICE** for Auto Mechanics, p. 86.)

The work of Grade XII is to involve diagnosis and servicing of common mechanical and electrical troubles with emphasis on preventive and periodic service rather than breakdown and heavy repair work.

1. Engine:

- (a) Construction: a thorough study of a typical modern automobile engine; standards of accuracy and precision; service work to maintain original standards.
- (b) Identifying parts likely to require replacement; reconditioning or adjustment due to wear.
- (c) Diagnosing engine mechanical defects:
 - (1) Testing for loss of power through leaking valves, pistons and gaskets.
 - (2) Testing for loose or worn pistons, worn cylinders, piston pins and bearings.
 - (3) Locating causes of overheating.
 - (4) Locating causes of excessive oil consumption.
- (d) Reconditioning or replacing engine parts not covered in Grade XI, such as cylinders, pistons and bearings.

2. Automotive Electrical Practice:

- (a) Use and care of elementary automotive electrical test equipment; test lamp, voltmeter, ammeter; diagnosing electrical troubles, system of elimination.
- (b) Testing storage battery: state of charge and defects; common storage battery troubles; care of the storage battery.
- (c) Remote controlled starter system: popular types of starter drives; identification of circuits, locating faults in system; testing starter motor input current and output torque; dismantling and assembling starter motor, and testing internal windings.
- (d) Generator output control methods; third-brush regulation and voltage control; identification of circuits; locating faults in generator system; testing generator for output; dismantling and assembling generator, and testing internal windings; testing and adjusting voltage regulator.
- (e) Types of ignition systems in common use: two-arm timers; common ignition system troubles, proper procedure for diagnosing ignition troubles; testing spark plugs; ignition coil; condenser; spark control methods; checking automatic spark control for accuracy; replacing and adjusting timer contacts; setting ignition timing; synchronizing two-arm timers.
- (f) Types of headlamps commonly employed; sealed-beam units; replacing headlamp units; testing for poor headlamp illumination; headlamp glare; aiming headlamps to meet requirements of law; headlamp control methods; protective devices, fuses; current limit relays.

3. Fuel System:

- (a) Construction and operation of typical modern carburetor; double-throat carburetors, types and purposes.
- (b) Dismantling and assembling carburetor to discover parts commonly requiring replacement, reconditioning or adjustment; carburetor adjustments and settings.

4. Engine Tune-up Operations:

- (a) Determining engine mechanical conditions before proceeding with engine tune-up; use of compression gauge and vacuum gauge; testing compression; checking valve clearance; inspecting engine lubricant.
- (b) Operations in engine tune-up and importance of correct sequence: valve clearance; battery condition; generator voltage; ignition system units; fuel system units; carburetor adjustments; vacuum test.

5. Transmission System:

- (a) Common clutch troubles; reconditioning modern clutch; replacing clutch facings and bearings; aligning clutch; clutch adjustment.
- (b) Construction and operation of popular form of synchronized type gear box; troubles likely to be encountered; making minor adjustments.
- (c) Types of universal joints and their different service requirements.
- (d) Diagnosing for various rear axle troubles; gear mesh and gear lash required.
- (e) Removing, replacing and adjusting rear axle gears.
- (f) Gear lubricants for particular requirements.

6. Running Gear:

- (a) Types of front wheel suspension.
- (b) Common troubles of steering gear, causes and remedies; checking front wheel alignment; steering geometry; adjusting steering gear and linkage on modern independent wheel suspension.
- (c) Construction and operation of modern hydraulic brake system; common troubles of modern brake system; replacing brake cylinder rubber seals and bleeding brake fluid lines.
- (d) Removing, replacing and adjusting complete set of brake shoes and drums.

DRAFTING

(ARCHITECTURAL AND BUILDING CONSTRUCTION)

(See also Related Course, **MACHINE SHOP PRACTICE** for Drafting, p. 88.)

1. Working Drawings:

- (a) Residence plans: preparation of working drawings of a small residence at $\frac{1}{4}''$ scale, complete with details, such as wall sections, windows, main entrance doorway, porches, cornice, bay windows, dormers, kitchen cupboards, staircase, mantel, and interior trim. Drawings to be traced in ink.

- (b) Mechanical equipment layouts: piping diagrams for hot-water heating and water-supply systems; duct layout for the heating and ventilating of a small building.
- (c) Structural steel details: working details using standard shapes for steel-framed floor bay, or similar project.
- (d) Surveys: drawing of land plot from notes prepared in field, showing buildings, natural features, levels, linear and angular measurements; measurement of building details.

2. Building Methods and Materials:

The work of Grade XI extended to include:

- (a) Running lines and staking out.
- (b) Organization of work and sequence of trades.
- (c) Study of plumbing installations including materials and construction of drains, soils, wastes, vents, traps, fixtures, septic tanks, hot and cold water supply, gas piping.
- (d) Heating installations; comparison of warm air, hot water, and steam systems; gravity and forced circulation; boilers, radiators, pipe and fittings, controls; elements of air-conditioning; fuels; calculations for heat loss, radiation, duct work; insulation—types, points of application.
- (e) Electrical work: service entry, switches, distribution, circuit arrangements; armoured cable, non-metallic cable and rigid conduit installations.
- (f) Study and preparation of specifications for a small residence covering excavation, masonry, rough and finished carpentry, lathing and plastering, sheet metal and roofing, tile and marble work, painting and glazing, plumbing, heating, and electrical work.

3. Estimating:

- (a) Approximate methods of estimating building construction by the cubic foot and square foot.
- (b) Consideration of the units of measurement, methods of estimating and pricing for: general items, excavation, grading, brickwork, mortar, rough and dressed stonework, concrete, concrete block, waterproofing, rough wood framing, sheathing, siding, shingles, frames and sash, exterior and interior doors, finished carpentry, trim, fittings, wood flooring, linoleum, sheet-metal work, built-up roofing, lathing, plastering, painting, glazing, marble, tilework, electric wiring, heating, plumbing, insulation.
- (c) Application of (b) above in taking off quantities for student's residence plans.

4. Structural Design:

- (a) Extension of Grade XI work to calculation from formulae of bending moment and section modulus for uniformly distributed, concentrated, cantilever, or combined loads.
- (b) Design of steel lintels, and beams in shear; lateral bending, and deflection; design of steel columns.
- (c) Use of hand-books in solution of structural problems.

5. Perspective and Rendering:

- (a) Extension of Grade XI work to include instrumental perspective of architectural subjects in angular or parallel perspective.
- (b) Use of conventional architectural shades and shadows.
- (c) Problems in rendering using pencil, pen and ink, monochrome, or full colour.

6. History of Architecture and Design:

- (a) Continuation of Grade XI work in the history of architecture, with emphasis on the mediaeval, renaissance, and modern periods. Materials and methods of construction to be stressed. Freehand or formal drawings of details.
- (b) Consideration of factors in design such as proportion, balance, unity, and scale as seen in historical examples, or objects of everyday use.
- (c) Influence of materials, utility, and methods of fabrication in architectural or industrial design.

DRAFTING

(MECHANICAL)

1. Machine Drawing and Design:

Design of small typical machines such as lathe, drill press, punch press, scroll saw, grinder, shaper.

- (a) Gathering data from catalogues, hand-books and reference books.
- (b) Calculations of speeds and feeds, and sizes of gears and pulleys; selection of materials; discussion of pattern-making problems and moulding practice; methods of lubrication.
- (c) Shafts and couplings: flange couplings, shaft collars, fluted and splined shafts, universal joints, flexible couplings.
- (d) Bearings: babbitt, bronze, roller, ball.
- (e) Sketching machine parts to determine approximate dimensions; making layout in pencil.
- (f) Detail and assembly drawing, checking, tracing in ink, blueprinting.
- (g) Preparing weight sheets, cost sheets and material shop orders.

2. Gearing Problems:

- (a) More advanced problems in spur and bevel gears; racks and pinions; spiral gears.
- (b) Drafting problems in the layout of such devices as planer reversing mechanism, pawl and click type ratchets, chain gear or sprockets, gear chains.
- (c) Transmission problems involving gears, shafts and bearings such as a geared winch or other geared drives or mechanisms.

3. Dies and Die Design:

- (a) Types of dies: blanking, punching, bending, bulging, drawing, follow, shearing, forming.
- (b) Parts of a die set: die shoe, die, stripper plate, guide pins, dowel pins, punch, punch holder, shank, guide-pin bushings, stops; die set materials.
- (c) Layout and drawings for a punching and blanking die set complete with specifications for materials.

4. Structural Steel Drawing:

- (a) Graphical solutions for stress diagrams of simple frames such as derrick frames, Pratt and Fink trusses.
- (b) Design of a simple Fink truss complete with calculations for members; use of the structural steel hand-book; the selection of standard shapes; efficiency of riveted joints; applications of mathematics for calculating bevels and accurate layout.
- (c) Bill of materials and weight sheets; use of letter indications and match marks for assembly; erection diagrams.

5. Sheet Metal Pattern-drafting:

Problems combining several methods of development of surfaces; triangulation and radial line method applied to such projects as the layout of ventilators, tapered funnel top, measuring can, layout of cornice and cornice mitres, sheet-metal caps and finials; the development of the sphere and hemisphere using the gore and zone methods.

6. Strength of Materials:

- (a) Design problems involving elements of strength of materials: simple tension, compression, bearing, direct shear and bending or deflection; unit stress, ultimate stress, elastic limit, safe working stress, factors of safety; use of hand-books to determine physical properties of materials.
- (b) Design of some simple machine such as a hoisting block for a crane.

7. Modern Pictorial Drawing Practice:

Introduction only.

8. Drafting Office Routine:

Drafting office organization: filing and routing systems, division of staff duties and responsibilities.

APPLIED ELECTRICITY

(See also Related Courses: **DRAFTING** for Applied Electricity, p. 83; **MACHINE SHOP PRACTICE** for Applied Electricity, p. 90.)

A. INSTALLATION AND MAINTENANCE

1. Circuits:

- (a) Distribution systems in non-metallic, metallic and rigid conduit circuits for light, heat and power, such as might be used in modern apartment buildings and small factories.
- (b) Practical installation of A.C. motors using different types of starters and protective devices commonly used in industry.

2. Maintenance:

- (a) Locating troubles in generators, feeders, motors, and industrial control apparatus; methods of repair.
 - (b) Insulation: specifications of the insulation of high-tension and low-tension conductors when installed in motors, starters, switchboards and distribution systems.
 - (c) Rewinding: stripping, securing winding data and rewinding a single-phase and a three-phase induction motor; making all necessary tests before, during and after rewinding.
3. Specialized services, such as one or more of the following: signal systems, radio service and armature winding.

B. THEORY AND TEST

1. Elements of Alternating Current:

- (a) The development of the sine wave as obtained from actual test compared with the geometric construction of the wave.
- (b) Frequency, alternation, cycle and effective value of sine wave for voltage, current, power and flux.

2. Alternating Current Circuits:

- (a) Inductance, capacitance, reactance and impedance.
- (b) Application of Ohm's Law to alternating current circuits.
- (c) Current and voltage relations in A.C. series and parallel circuits.
- (d) Measurement of power and power factor including the meaning of the terms phase, phase angle, lagging and leading currents; actual measurement of power in non-inductive, inductive, and capacitance circuits to determine the relation between apparent, reactive and effective power; actual measurement of power in single, two and three-phase circuits.

3. Alternating Current Generators:

- (a) Construction of typical single and multiphase generators.
- (b) Principles of action for simple and multiphase distribution of windings; possible combinations of conductors to eliminate copper.
- (c) Parallel operation of generators involving synchronizing by use of lamps.

4. Alternating Current Motors:

- (a) Experimental study of the revolving magnetic field.
- (b) Comparison of starting characteristics produced by single and multiphase fields cutting a short-circuited armature winding.
- (c) The construction and commercial uses of three-phase squirrel-cage and wound-rotor induction motors, including an experimental study and calculation of transformer effect, slip, speed characteristics, starting current, full-load current, power factor, torque and efficiency characteristics.
- (d) The construction and commercial use of single-phase induction motors, including a study of special starting devices, construction and arrangement of windings, starting currents, torque, speed characteristics, power factor and efficiency.

- (e) The construction and commercial use of synchronous motors, including a study of starting methods, power factor and speed characteristics, power factor correction, and efficiency.
5. Calculation of wire sizes for various distribution systems.
6. Insulation:
- (a) Study of the characteristics and applications of different kinds of insulating materials used in industry for protection of low and high-tension conductors.
 - (b) Specifications of insulation of coils, lead, terminals, splices, iron core, turns, coil coverings, including the protection and factors governing the design of coils.
 - (c) Specifications of insulating varnishes and transformer oils for electrical apparatus.
7. Transformers:
- (a) Construction, principles of action, efficiency, load characteristics, and commercial uses.
 - (b) Transformer connections, star, delta, "T" or Scott connection, open delta, for light, heat and power.
8. Instruments:
- An elementary study of the theory of operation, uses and proper line connections of such instruments and meters used commercially to measure alternating current, voltage and power, as ammeters, volt-meters, single and polyphase watt and watt-hour meters, maximum demand meters and synchrosopes.

APPLIED ELECTRONICS

A. THEORY AND TEST

At the beginning of Grade XII the student should indicate whether he intends to specialize on radio work or industrial electronics. This will determine the percentage of radio assignments that should be given as opposed to industrial electronic assignments. The topics listed below are not necessarily in the required teaching order.

1. Vacuum Tubes—further consideration of vacuum tubes:
- (a) Characteristic curves of tetrode and pentode—sharp cut-off and variable types. Reasons for use of these tubes.
 - (b) Study of tube constants—mutual conductance or transconductance, amplification factor and A.C. plate resistance.
 - (c) Consideration of power amplification—the load line, operating point, load matching. Power amplification versus voltage amplification.
 - (d) Special purpose tubes—construction and operation of double purpose tubes, converter tubes, beam power tubes, electric eye, special rectifiers.

2. Circuit Elements—further consideration and selection of topics to depend on nature of course and equipment available:
 - (a) Application of beat note principle—beat note audio oscillator or a superheterodyne circuit.
 - (b) Automatic volume control circuits.
 - (c) Phase inversion circuits.
 - (d) Inverse feedback circuits.
 - (e) Voltage doubler circuits.
 - (f) Vibrator power supplies.
 - (g) Automatic frequency control as applied to automatic tuning.
 - (h) Multivibrator circuit.
 - (i) Pulse forming and sharpening circuit.
3. Alternating Current Theory—advanced quantitative considerations. Use vector diagrams liberally.
 - (a) Inductance, calculations of: the henry, current lag, coil reactance, inductance and resistance in series, phase relations, impedance.
 - (b) Capacitance (the farad)—calculations of condenser values, current lead, capacity and resistance in series, phase relations, impedance.
 - (c) Frequency-reactance graphs and frequency-impedance graphs for coil and condenser.
 - (d) Inductance, capacity and resistance in series and parallel, resonance calculations, selectivity curves.
 - (e) Power factor relations, active and reactive current components.
 - (f) High frequency effects, distributed capacity and skin effect.
 - (g) Transient effects on D.C. and A.C.
 - (h) Filters: high, low, band pass and band rejection filters. Characteristics.
 - (i) Elementary transmission line theory—impedance matching, image impedance.
4. Photoelectric Effects: types of cells, vacuum, gas filled and photronic cells.

Construction and principle of operation, colour sensitivity, application in control circuits.
5. Cathode Ray Tube and Oscilloscope:
 - (a) Construction and operation of cathode ray tube—electrostatic and electromagnetic.
 - (b) Voltage supplies for cathode ray tube and methods of control.
 - (c) Use of electronic switch on cathode ray tube.
 - (d) Sweep circuits for cathode ray oscilloscope operation, including synchronizing.
 - (e) Applications of cathode ray tube for distortion indication, gain, timing, synchronizing, frequency determination, phase relations, circuit alignment.
6. A.C. and D.C. motor characteristics, including simple control and starting devices.

7. Gaseous Tubes:

- (a) Diodes: characteristics, ionization, gas types, pressure and its effect on firing potential. Application as rectifier, regulator and oscillator; the tungar tube.
- (b) Triodes:
 - (1) Characteristics, principle of operation, comparison with vacuum tube—noting non-continuous control characteristic of gaseous triode.
 - (2) Use of gas triode with condenser resistance feedback and D.C. applied to provide timed control of firing.
 - (3) Use of gas triode as switch with D.C. potentials applied.
 - (4) Use of gaseous tube as rectifier with A.C. applied to plate and noting effect of variation of grid D.C. potentials.
 - (5) Gas tube as rectifier—controlling by changing grid phase relations with respect to plate voltage, also amplitude control.
 - (6) Gas triode as controlled oscillator—generating saw tooth and square wave, the multivibrator.
 - (7) Gas triode as voltage regulator and comparison with pliotron regulators.
 - (8) The saturable core reactor and its application in circuits.
 - (9) The peaking transformer and its application.
 - (10) Examples of industrial control and regulation by thyratrons, ignitrons and pliotron application to motor control, welding control, elevator control, location of defects in objects on assembly line, counting, sorting, grading, measuring within limits, etc.

8. Test Equipment—consideration of circuits used and operation of specialized service equipment.

- (a) A.C. instruments—thermocouple, hot wire, electrostatic, iron vane, rectifier and dynamometer types.
- (b) The vacuum tube voltmeter—application to alternating current, direct current and high resistance measurements.
- (c) Inductance and capacitance bridges.
- (d) Signal tracing methods of analysis.

9. Specialized Subjects—optional—if time and apparatus permit:

- (a) Frequency modulation.
- (b) Microwave transmission and reception.
- (c) X-ray tubes and applications in industrial and medical work.
- (d) Transmitter considerations—circuits, tests, adjusting.
- (e) Antennae, types, characteristics, radiation pattern, wave reflections in the ionosphere.
- (f) Transmission line theory and application in telephone program links. Impedance matching at R.F.

- (g) Radio broadcast studio technique.
- (h) Television, facsimile transmission and reception.

NOTE:—It is recommended that students taking the course in Applied Electronics be given part-time studies in the regular Electrical Theory Course for a consideration of the characteristics of A.C. and D.C. motors—or that this topic be taken as a part of this course as outlined in Item 6.

B. SHOP COURSE

1. Construction and test of a beat note oscillator to illustrate the heterodyne principle, and a power amplifier of the push-pull type.
or
Construction and test of a superheterodyne receiver.
2. The addition of special circuits such as those taken in Part A—Theory and Test—phase inversion, inverse feedback, etc.
3. Construction and test of a photo cell amplifier and relay controlled device.
4. Construction and test of power supplies using various voltage regulating devices.
5. Construction and test of a fluorescent lighting unit.
6. Construction and test of special saw tooth generators and square wave generators using the thyatron tube. (Neon tube may be used first.)
7. Construction and *test* of voltage supplies and sweep frequency supply for cathode ray oscilloscope.
8. Construction of a medium power oscillator to illustrate induction and dielectric heating effects. Test of same.
9. Construction and test of single and double tube inverters for control of small A.C. motors.
10. Construction and test of thyatron control device for small D.C. motors.
11. Construction and test of an electronic stroboscope.
12. Construction and test of a three-phase rectifier.
13. Construction and test of an electronic frequency changer.
14. Construction and test of control circuit using ignitrons—for welding control or motor control.
15. Construction and test of a small precipitron.
16. Construction of circuits to illustrate the use of gas tubes in circuit protection, i.e., overload, underload, overvoltage, undervoltage, etc.

It is recommended that the electronic students either be given part time in the regular electrical course for consideration of A.C. and D.C. motor operation or that this be added to their course.

Those students specializing in the communications end of electronics may substitute work on transmitters and special receivers for items 11 to 16 in the above outline.

MACHINE SHOP PRACTICE

1. Hand Tools and Bench Work:

- (a) Filing and scraping: production of true and parallel surfaces; machine slide fitting, production of curved surfaces, bearing fitting.
- (b) Lapping hand: suitable abrasives, preparation and application of abrasives; testing surfaces.
- (c) Bearing lining: suitable materials; tinning and anchoring metals; preparation of arbor and collars; sealing and venting; pouring and peining metals.
- (d) Chipping as required: as a corrective measure; in repair work.

2. Layout and Gauging:

More advanced layout work involving tool-makers' buttons and trigonometry; construction and use of dial and test indicators; use of depth and height gauges.

3. Machine Work:

- (a) Lathe:
 - (1) Eccentric turning, external and internal.
 - (2) Thread cutting: (i) acme and buttress threads, (ii) cutting right and left-hand threads, external and internal, (iii) multiple threads, (iv) rechucking work with the indicator dial, (v) recentering work using the indicator.
 - (3) Centre spacing on face-plate, using tool-makers' buttons.
 - (4) Forming tools; use of backing off attachment.
- (b) Shaper: study of Whitworth and oscillating link motions and application; advanced problems involving accuracy and special set-ups.
- (c) Miller: making various tools, such as hobs; cutting spur gears, cutting bevel gears, cutting and hobbing a worm gear; spiral cutting, differential indexing; miscellaneous milling continued.
- (d) Drill press: further work to develop accuracy and technique; setting up irregularly shaped work; clamping to avoid stresses; jigs and fixtures.
- (e) Grinder: reamer grinding, straight and spiral flutes; form cutter grinding; drill grinding; internal grinding, cylindrical and tapered; internal grinding in lathe.

4. Metallurgical Work:

- (a) An elementary study of and experience in the use of the thermocouple and pyrometer.
- (b) Examination of sections with a view to determining the granular structure and its corresponding physical characteristics.
- (c) Further practice in annealing and case hardening.

5. Welding:

Oxy-acetylene welding or brazing as may be required for construction or repair work; cutting with the torch; flame hardening.

MINING

A. GEOLOGY

1. Ore Minerals:

- (a) A review of the principal ore minerals, especially those found in Ontario.
- (b) Minerals commonly associated with the important ore minerals.
- (c) Rock associates of common ore minerals.

2. Geological Processes of Formation:

- (a) Origin of source of the ore-bearing minerals.
- (b) Types and shapes of ore deposits, relation of country rock to ore body.
- (c) Secondary geological processes that aided in the concentration of the ore.

3. Description of Ore Deposits Associated with Intrusive Igneous Rocks:

- (a) Gold deposits, Porcupine, Kirkland Lake, South Africa.
- (b) Silver deposits, Cobalt.
- (c) Copper deposits, Noranda, Flin-Flon, British Columbia. Porphyry coppers.
- (d) Lead-zinc deposits, Sullivan, Kingdon, Sudbury.
- (e) Copper-nickel deposits, Sudbury, Finland.
- (f) Chromium, Canada.
- (g) Tin, Cornwall, Canada.

4. Description of Ore Deposits Formed by Other Geological Processes:

- (a) Aluminum deposits, British Guiana, Arkansas.
- (b) Tin deposits, Malaya.
- (c) Nickel deposits, New Caledonia.
- (d) Iron deposits, Lake Superior, Gunflint Range, Michipicoten, Cuba, Wabana, Alabama.

B. MINING

1. Rock Drills:

- (a) The general construction and uses of the important types of hammer drills, drifter, plugger, stoper.
- (b) Necessity and means of rotating the drill steel, drill steel bits, drill changes.
- (c) Mountings of rock drills.

2. Development Work:

- (a) Development work as compared with exploration work.
- (b) Shaft-sinking, location of development shafts, vertical and inclined shafts, rounds used, steps in taking out a shaft round, handling muck and water, station cutting, shaft timbering, safety precautions.
- (c) Drifting and crosscutting:—purposes, rounds used, organization of crews, safety precautions.
- (d) Raising:—purposes, rounds used, timbering, safety precautions.

3. Mining Methods:

- (a) Open pit mining, when used, general layout of open pit mines, drilling and blasting, handling ore.
- (b) Shrinkage stoping in narrow veins, development necessary, steps in opening the stope, support of stope by timbering or rock pillars, construction of chutes, drawing ore.
- (c) Shrinkage stoping in wide veins and masses, comparison with method in narrow veins, support of hanging wall, removing rib and floor pillars.
- (d) Cut and fill stoping, development required, opening of stope, steps followed in removing cuts, sources of fill, comparison with shrinkage stoping.
- (e) Square set stoping, when used, development work required, steps in removing blocks of ore, timber framing.

4. Explosives:

- (a) Types of explosives used in mining, dynamites, low freezing dynamites, ammonia dynamites, gelatin dynamites, liquid oxygen.
- (b) Handling explosives, storing, thawing, transporting, loading in holes.
- (c) Detonation, safety fuse, electric blasting, capping fuse, making the primer, delayed action fuses.

5. Sampling:

- (a) Purpose and methods of sampling, core drill, churn drill, chip samples, grab samples, channel sampling.
- (b) Channel sampling, preparing the face, cutting the sample, sample intervals, marking the sample.

C. MILLING

1. Introduction:

- (a) Purpose served by milling an ore, terms used in ore dressing.
- (b) Properties of minerals made use of in ore dressing: specific gravity, adhesion, magnetic permeability, colour and lustre.

2. Preparation of Ore:

- (a) Coarse and intermediate crushing, jaw and gyratory crushers, cone crushers, rolls.
- (b) Fine grinding, ball mills, rod mills, tube mills, operation of crushing machinery.
- (c) Sizing, fixed screens, revolving screens, shaking screens, vibrating screens, screen analysis.
- (d) Classification, hydraulic classifiers, mechanical classifiers, de-sliming classifiers.

3. Gravity Concentration:

- (a) Shaking tables, principle of action, types, Wilfley, Plat O, Butchart, Deister, Overstrom.
- (b) Field of use gravity concentration, advantages and disadvantages.
- (c) Disposal of concentrate.

4. Flotation:

- (a) General principles, production of froth, surface properties of minerals, ores amenable to flotation.
- (b) Reagents, frothing agents, collection agents, depressing agents, re-activating agents, dispersion agents, conserving agents.
- (c) Flotation machines, MacIntosh, Fahrenwald.
- (d) Flotation flowsheets, simple flowsheet for ore with one valuable mineral, differential flotation flowsheets.
- (e) Dewatering and disposal of flotation concentrates.

5. Laboratory:

Complete flotation tests on samples of simple and of mixed ores.

D. METALLURGY

1. Metallurgy of Gold and Silver:

- (a) Preparation of ore, crushing, grinding in closed circuit in cyanide solution.
- (b) Solution of gold, agitation and aeration.
- (c) Separation of gold solution from solids, thickeners, filters, clarifiers, counter current decantation.
- (d) Precipitation of gold from solution, zinc shavings, zinc dust, vacuum process.
- (e) Refining precipitate, melting bullion, fluxes, disposal of products, sampling gold bullion, assay of gold bullion.
- (f) Chemistry of cyanide process, basic solution, need of air, cyanicides.

2. Metallurgy of Copper-Nickel:

- (a) Roasting, purpose, roasting furnaces construction and operation, chemical reactions, roasted product, sintering.
- (b) Smelting, construction and operation of reverberatory furnace, chemical reactions in smelting, smelting products, blast furnace smelting.
- (c) Converting, construction and operation of converters, chemical reactions in converting, disposal of converter products.
- (d) Separation of copper and nickel sulphides, Orford process, method of operation, chemical reactions, disposal of products.
- (e) Refining of nickel matte, Mond process, electrolytic processes.

E. WET ASSAYING

1. Determination of Copper in Ores and Metallurgical Products:

- (a) Iodide method, starch solution, reagents required, treatment of an ore, standardizing thiosulphate solution, titration, rapid assay by the iodide method.
- (b) Electrolytic method, preparation of solution, electrolysis of the copper solution, care of the cathodes.
- (c) Cyanide method, purpose, standardizing of cyanide solution, treatment of an ore titration.

2. Determination of Iron:

- (a) Permanganate method, standardizing permanganate solution by means of metallic iron, ferrous ammonium sulphate or oxalic acid, treatment of an ore, preparation of iron-bearing solution, titration.
- (b) Dichromate method, solutions required, standard potassium dichromate treatment of an ore and titration.

3. Determination of Nickel:

- (a) Cyanide method:—preparation of reagents, standardizing cyanide solution, preparation and purification of nickel-bearing solution, titration.
- (b) Electrolytic method, treatment of the ore, preparing nickel-bearing solution, conditions for electrolysis.
- (c) Dimethylglyoxime method, preparation of nickel-bearing solution, precipitation of nickel glyoxime, filtering, drying, and weighing.

4. Determination of Zinc:

- (a) Ferrocyanide method, standardizing ferrocyanide solution, treatment of an ore, purification of zinc-bearing solution, titration, indicator.

5. Determination of Lead:

- (a) Chromate method, reagents, required, treatment of an ore, precipitation of lead, as chromate, treatment of precipitate, titration.

6. Rapid Determinations:

- (a) Silica, precipitation as insoluble residue and weighing.
- (b) Sulphur, fluxing to convert to sulphate, precipitation as barium sulphate, weighing.

F. SURVEYING AND MAPPING

1. Traverses:

- (a) Survey of a closed traverse with chain and transit, survey notes, closing error, calculation of latitudes and departures, plotting by latitudes and departures.

2. Survey for excavation and calculation of excavation, approximations, area grading.

3. Surveying by Stadia, method explained, Stadia rod, inclined readings.

4. Mine Surveying:

Location and form of station marks, instruments used, shaft plumbing, survey of raise, calculation and plotting of co-ordinates.

PRINTING

(See also Related Course: **ART** for Printing, p. 78.)

1. Display:

- (a) Definition and history:

- (1) Analyzed and defined.
- (2) Classified as to medium—newspaper, magazine, direct mail.
- (3) Origin, purpose, development and growth.

(b) Functions:

- (1) To attract.
- (2) To interpret.
- (3) To induce action—modes, methods, devices.

(c) Essential elements:

- (1) Legibility: types, measures, breaks.
- (2) Simplicity: how achieved.
- (3) Unity or purity of style: type faces, grouping, arrangement, consistent treatment.

(d) Planning or designing:

- (1) Analysis: nature of job, nature of business or product, to whom addressed, probable reading conditions, effect of these factors on the design or treatment of the piece.
- (2) Analysis of copy: relative importance or value of parts, choice of dominant and secondary points for display.
- (3) Preliminary sketches: experimental pencil work, possible and alternative treatments in design, choice of most promising sketch.
- (4) Choosing type faces: factors involved—space, measures, illustrations, copy, medium.
- (5) Making the layout: details required—dimensions, margins, borders, rules, lettered lines, blocked masses, illustrations, positions, and specifications.

(e) Principles:

- (1) Harmony: shape and direction, type to paper, materials—type, illustrations, rules, borders, ornaments; tone—grays, blacks, faced, colours.
- (2) Contrast: black and white, large and small, different faces, grouping or use of white space, colour; danger of over-emphasis or wrong emphasis.
- (3) Proportion: width to length, type area to paper area, margins, parts to whole and to each other, type size to page size; laws, ratios, factors.
- (4) Balance and symmetry: points of balance—optical centre, line of golden proportion; kinds of balance—formal, informal; symmetrical or conventional *vs.* modern layouts.

2. Illustrations:

- (a) Kinds: line, Ben Day, halftone, linoleum, rubber, wood.
- (b) Choice: for paper, job, conditions.
- (c) Placing: position, direction, motion, rhythm.
- (d) Reproductions: stereo, electro, nickeltype.

3. Colour:

- (a) Purpose, value, effect, number of.
- (b) Display considerations: legibility, making sense, completeness.
- (c) Mechanical factors: splitting the form.

4. Advertisements:

Financial, product, entertainment, travel, chain and departmental store, and general, analyzed as to characteristics and traditions.

5. Press Work:

The work of Grade XI to be reviewed and expanded as facilities will permit. Practical applications required. These to be found on actual production of live jobs for school use.

SHEET METAL

(See also Related Course: **DRAFTING** for Sheet Metal, p. 85.)

1. Pattern Development:

- (a) An extension of the parallel line and projection methods of developing patterns for round and rectangular pipe and duct fittings, skylight curbs; common, ridge, hip and jack bars; conductor heads and finials; cornice mitres (face and return); intersections on irregular surfaces.
- (b) Radial line development: round and rectangular eccentric tapers, stack heads, rectangular Y's and offsets, guards for machine belts and gears.
- (c) Triangulation: eccentric transition fittings, machine and forge hoods, Y-branches from round pipes of equal and unequal angles and diameters, rectangular Y-branches with different areas for ventilation systems, regular and compound offsets.

NOTE:—All patterns for pipe and duct fittings to entail the use of seams commonly used in the fabrication and assembling of blower and ventilation systems.

2. Seams and Joints:

- (a) Blower and ventilation systems: all seams involved in the fabrication and assembling of ducts, etc., such as riveted, slip double seam, built-up hammered lock, drive cleat, S-cleat, standing seam and slip lock.
- (b) Roofing and ceiling: cross and longitudinal joints for flat lock, standing seam and batten roofing; expansion joints for eavetroughs, box gutters and roofing; types of joints used on manufactured metallic ceiling, roofing and siding.

3. Oxy-acetylene Welding:

Care and use of tanks, gauges, hose, torch tips and valves; setting up and assembling outfit; lighting and regulating flame; welding and brazing light sheet steel and small structural shapes used in reinforcing and bracing sheet-metal tanks.

4. Machine Operations:

- (a) A more extensive use of the bending brake in forming eavetroughing, cornice and copings; the use of special forming attachments for the brake.

- (b) A wider use of the small machines (elbow edging and setting down, wiring, turning and burring) in the fabrication of pipe fittings; adjusting heads for end-play; correct position for various gauges of metal used.
- (c) Foot squaring shears: replacing, lining up and adjusting blades for shearing light and heavy metals.

5. Hand Operations:

Raising, bumping, planishing, dressing; stretching and shrinking edges.

WELDING

(OXY-ACETYLENE AND ELECTRIC ARC)

A. ACETYLENE WELDING

1. Structural Steel Welding:

Study of structural steel shapes; angle iron, channel iron I-beams, H-beams; sizes and weight of structural steel shapes; methods and types of welded joints used in welded structural steel; strength of welds in comparison to riveted joints; gusset plates and their uses in joining structural steel.

2. Pipe Welding:

Advantages of welding in pipe-fitting; classification of piping as standard, heavy, extra heavy; sizes of piping; methods of cutting piping; bending piping; types of fittings used for joining pipes; types of welded joints used on piping; laying out templates for welded bends in piping. Practice in laying out and welding two-piece 90° bend, three-piece 90° bend, two-piece 45° bend, three-piece 45° bend, tee joints and Y-joints in welded pipe work; use of backing-up rings when making pipe-welds. Brazing galvanized piping; brazing copper piping.

3. Automotive Welding:

Steels used in automobile construction; discussion on advisability of welding automotive parts; methods of welding breaks in chassis; welding car fenders; brazing car bumpers using straps; tools used for body work; use of soft solder for body repairs.

4. Aluminum Welding:

Uses of aluminum; properties of aluminum sheet and castings. Necessity of pre-heating aluminum; importance of supporting aluminum when welding. Aluminum rods used for welding; flux method and puddling method of aluminum welding; welding cast aluminum; welding sheet aluminum. Types of welded joints used in aluminum welding.

5. Lead Burning:

Application of lead burning in industry; use of oxy-hydrogen flame in lead burning; welding lead seams; welding lead piping; practice in making lead joints on lead sheets.

6. Silver Soldering:

Uses of silver soldering; grades of silver solders for joining various metals; melting points of silver solders; preparation of joints for silver soldering; use of clamps and jigs for silver soldering of saws; silver soldering copper and brass tubing.

7. Brass and Bronze:

Properties of brasses and bronzes; uses of brass and bronze; information on the welding of brass and bronze; practice in welding brass and bronze castings.

B. ELECTRIC ARC WELDING

1. Vertical Arc Welding:

Advantages of vertical arc welding; advantages of up and downward travel when vertical welding; procedure when vertical welding. Current values for vertical welding; high speed vertical welding on sheet iron; position of electrode for vertical welding.

Overhead welding; necessity for overhead welding. Technique of overhead welding; practice on butt and corner joints in vertical and overhead positions.

2. Carbon Arc Welding:

Sizes and current values of carbon electrodes; preparing carbon electrodes for welding; use of filler rods for carbon arc welding; position of carbon and filler rod when welding; practice work, joining steel with the carbon arc; using the carbon electrode for cutting steel.

3. Structural Steel Welding:

Application of the electric arc in structural steel fabrication; use of plug-welds for joining parts; advantages of the electric arc, and comparison with oxy-acetylene welding.

4. Pipe Welding:

Uses of the electric arc in pipe welding; practice on pipe joints using the electric arc.

5. Cast Iron Welding:

Advantages of the electric arc for welding cast iron. Procedure when arc welding cast iron; use of Ferro-weld and G.E. Type A cast iron electrodes. Other types of electrodes for cast iron welding; application of cast iron welding for automotive cylinder blocks; disadvantages of electric arc welding of cast iron.

6. Welded Design:

Study of castings to determine changing from cast to welded construction; strength of cast iron in comparison to steel; redesign of some type of casting as practice in applying welding to machine design.

7. Hard Surfacing:

Hard surfacing of parts to increase wear to abrasion corrosion; application of hard surfacing alloys; uses of stellite for cutting tools; types of stellite and their uses; other hard surfacing alloys; practice work in stelliteing low carbon steel for use as cutting tools using the electric arc and oxy-acetylene processes.

8. Welding Machines Using Power Tubes:

Types of power tubes for control of welding machines; ignatron tube; principle of the ignatron control; application of the ignatron rectifier in spot-welding.

9. Welding Tests:

Types of tests used in welding; tensile strength; elongation, elastic limit; testing by the magnaflux method; use of X-rays when testing welds; impact tests; fatigue tests; hardness tests; microscopic tests.

10. Costs:

Methods of determining cost in welding; overhead in shops; weights of welding rods; consumption of gases for sizes of welding tips and length of time used; uses of cost cards; making up a cost card; importance of good welding; necessity for testing welders in business.

WOODWORKING—CABINET-MAKING

Projects are to be selected that require the general use of cabinet tools. Some special attention is to be given to the construction and use of plywood and the matching and laying of veneer. Some elementary instruction in hand carving is to be given and should include the use of veiner, fluter, gouge and vee or parting tool.

1. Materials:

A study of foreign and native woods used in the cabinet trade; grades and methods of grading lumber; types of cut or sawn veneers.

2. Hand Tool Operations and Construction:

- (a) Tables (ends): solid and panel construction assembling.
- (b) Frames, undertops and parting rails in case construction; construction of drawers.
- (c) Gluing, clamping and squaring case goods.
- (d) Jointing and taping plain veneers.
- (e) Matching, jointing and taping face veneers.
- (f) Gluing up core, crossband and face veneer (plywood).
- (g) Veneer press: use of cauls (metal, wax paper or wax plywood parting pieces used in the press when gluing up to prevent individual units of plywood from sticking together).
- (h) Repairing checks or blisters on veneered stock.
- (i) Cutting and applying an overlay.

3. Machine Tools and Operations:

- (a) Cut-off saw: fitting, setting, jointing and filing.
- (b) Variety saw: gumming, setting, jointing and filing a rip saw; filing a dado saw; cutting concave with offset ripping fence.
- (c) Jointer and planer: grinding and setting knives.
- (d) Shaper: shaping to form; fluting; knife layout.

- (e) Router: set-up and adjustment; use of pin in routing to a pattern
- (f) Band saw: fitting and brazing; resawing.
- (g) Belting: methods of joining; principles of drives; principles of proper tracking.

4. Upholstering:

Box seat construction: springing up; webbing.

5. Finishing:

- (a) Stains: selection and mixing, highlighting and blending.
- (b) Filler: colouring; shellac cutting and colouring; dull satin and gloss finish.
- (c) Preparation of polish.
- (d) Varnish remover; refinishing; repairing (indented) finish.

WOODWORKING—CARPENTRY

(See also Related Course: **DRAFTING** for Carpentry, p. 82.)

The course is to include a more advanced study of the operations of Grade XI. Reading of plans, writing specifications, material cost, and a study of local municipal building by-laws are to be included.

1. Laying Out Site:

Use of batter boards; running lines, driving pegs; squaring by use of triangle and equal diagonal methods; levelling by the use of pegs and straight edge.

2. Bench and Mill Work:

- (a) Fitting a mortise lock, fitting lock striker, necessity and method of reversing action of lock, setting butt hinges, solid and loose pin.
- (b) Laying out porch steps; laying out stairs with winders; setting risers, treads, newel post; method of laying out bull-nose tread.
- (c) Method of making window-frames, window-sash; position of stiles, rails and muntins; storm sash; making a coped joint.

3. Construction:

- (a) Sill, joist and girder positions for brick and frame construction; studding; inside and outside sheathing (butt joint and shiplap).
- (b) Roof terminology; open and box cornice; grades of wood and asphalt shingles, method of laying; valley gutters and flashing; setting and fitting metal ridge roll on hip and ridge; use of framing square in laying out gambrel roof.
- (c) Scaffolding and roof appliances used in the course of construction.

4. Interior Trim:

Flooring (heavy and thin type), base-board, quarter-round, door jambs and casing, plinth, panelling and plate rail, picture mould, plain and mantel trim, fitting and nailing, scraping (hand and machine), sanding, seasoning; mitred and coped joints.

WOODWORKING—PATTERN-MAKING

(See also Related Course: **MACHINE SHOP PRACTICE** for Pattern-making, p. 91.)

1. Study of Materials:

Specifications for pattern supplies, sources, rules in buying, nomenclature.

2. Planning:

- (a) Pattern layout to show moulding procedures and machining.
- (b) Special pattern markings such as stop-offs, fillets, and loose pieces.
- (c) Adjustments in design of patterns for machining castings such as addition of lugs and bosses.
- (d) Storing and recording patterns.
- (e) Determine weights of castings from patterns and drawings.

3. Hand Tools:

Cutting tool design and angles; advanced tool technique.

4. Machine Tools:

- (a) Specifications for machine tools for woodwork; design of blades and cutters.
- (b) Machine speeds, cutting speeds.
- (c) Special cuts and jigs for machine work.
- (d) Discussion of pattern-making power tools for special work such as milling and gear cutting.

5. Types of Constructions:

- (a) Box and frame constructions including patterns of shell types built on forms; core boxes of same type having loose piece features with core prints attached by joints.
- (b) Patterns and core boxes of laminated construction such as ring forms, segmental work, wheel constructions presenting use of tongue joints; rechucking rims of circular section; matched parted patterns; turned core box cavities.
- (c) Formed patterns with irregular parting line; loose flange application with slab core such as offset pipe work.
- (d) Stave construction and turning.
- (e) Sweeps and templates for loam and plaster of paris patterns.
- (f) Master patterns: contractions, finish; metal patterns and working patterns.
- (g) Match plates: wood, metal, cast plates; attaching patterns to plates, forming and disposition of gates and runners; layout for one-sided plates, double-sided plates, irregular parting line plates; discussion of common types of moulding machines used in plate work.

6. Foundry:

- (a) Types of flasks: shaped, match plate, crane.
- (b) Use of chaplets: types, securing cores.
- (c) Suspended cores, cake and cover cores, draw backs.
- (d) Use of follow boards and match plates.
- (e) Green sand moulding with shell patterns.
- (f) Dry sand moulding, use of sweeps, loam moulding and core-making.

FARM MECHANICS

1. Drawing and Plan Reading:

- (a) Detail drawings of farm appliances such as bins, stalls, chutes, balers, work benches; timber roof trusses; culverts.
- (b) Sketches and working drawings of parts of farm implements from measurements made of the part.
- (c) Sheet metal drafting:
 - (1) Developing patterns for simple sheet-metal devices such as ventilators, T-pipes and elbows.
 - (2) Laying out mitre cuts for eavetroughs, cornices, ridge rolls and gutters.

2. Woodwork:

- (a) Tool sharpening: grinding, filing and whetting edge tools of any shape such as gouges, veining tools, auger bits, twist drills.
- (b) Construction and repair:
 - (1) Roof framing to include the use of the framing square to lay off common, hip and jack rafters, and straight stairs.
 - (2) General maintenance repairs.

3. Painting and Finishing:

The work of Grade XI extended with emphasis on the preparation of surfaces (new and old).

4. Forge and Sheet Metal:

- (a) Bending, shaping, welding and tempering operations used in making more difficult farm articles, and in repairing broken parts.
- (b) Construction and repair of sheet-metal objects such as tanks, ducts, hoppers and eavetroughs.

5. Farm Implements:

Dismantling, assembling, fitting, replacing, and renewing parts of farm machinery such as pumps, windmills and gears and bearings of implements.

6. Concrete Work:

- (a) Care and theory of operation of concrete-mixing machines.
- (b) Construction and use of irregular wood and metal forms.
- (c) Reinforcing and testing concrete.

7. Auto Mechanics:

An extension of the Grade XI course applied to field maintenance and emergency repairs of tractors, stationary engines and trucks.

RELATED COURSES

GRADES XI AND XII

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ART

RELATED INSTRUCTION FOR STUDENTS SPECIALIZING IN PRINTING

GRADES XI AND XII

1. Printing History:

The origin and development of letters. Ideographic records. Phonetic and cuneiform writing. Oriental scripts. Egyptian hieroglyphics. Phoenician, Greek and Roman influence. Mediaeval book making. Movable type. Intaglio printing. Individual research such as:

- (a) (1) Make notes and sketches on the origin and development of letters.
- (2) Study and sketch classic and modern manuscripts.
- (b) Construct and illustrate a booklet containing research, sketches and clippings; applying principles of cover design, layout, margins, title page, etc.
- (c) Create classroom display cards on:
 - (1) Early writing and printing.
 - (2) Early printers.
 - (3) Historical printing equipment.
 - (4) Make cut-outs of early and modern type faces.

2. Lettering:

- (a) Type styles: old style, transitional, modern.
 - (1) Set in type and print for class use a complete font of all type faces used in the school print shop. (Class project.)
 - (2) Classify each style as modern, transitional or old style.
 - (3) Make drawings showing difference in proportion, weight, serifs of each style.
- (b) Classification and characteristics: Roman, Gothic, Italic, script, and text.

- (1) Letter the words Roman, Gothic, Italic, Script and Text, in their respective types.
 - (2) Gather a number of examples of the five types from newspapers and magazines and paste into notebooks.
 - (3) Letter a number of words in type styles commonly used in present day magazines and newspapers.
- (c) Construction: Roman proportion; condensed and extended lettering; single stroke lettering; representing type faces; selecting and combining types. Light, medium and bold.
- (1) Construct single stroke caps and lower case in pencil and pen according to Roman proportion.
 - (2) Apply condensed and extended lettering to headings and wording in Section 1, part 3.
 - (3) Develop skill in representing common type faces quickly in pencil; upper and lower case and numbers.
 - (4) Gather and study the lettering used on layouts in the local newspaper offices.
 - (5) Letter words expressing weight, dignity, restraint, informality.
 - (6) Letter in one size the words LIGHT, MEDIUM and BOLD in their respective styles.

3. Layout:

- (a) Use and purpose.
Gather sample layouts:
 - (1) Newspaper and magazine ads, covers, business stationery.
 - (2) Advertising matter; folders, blotters, booklets, etc.
 - (3) Programmes, cards, tickets.

A file may be constructed with material catalogued.
- (b) Units of layout: headings, sub-headings, body matter, rules, ornaments, illustration, colour areas, trade-marks.
 - (1) The study of copy and breaking it into units.
 - (2) Letter simple headings with sub-headings in various types, using appropriate rules, ornaments, illustration and colour areas.
 - (3) Design simple trade-marks and crests for school clubs and functions. (Camera Club, Concert, Exhibition.)
- (c) Construction: a detailed study of the design principles and of the basic forms on which layouts are constructed. Balance, proportion, simplicity, beauty, tone, contrast, character, panels, diagonals, margins, etc.
 - (1) Prepare layouts using basic principles of proportion: Printers' oblong, Golden oblong, Regular oblong, Hypotenuse oblong.
 - (2) Prepare layouts for school functions expressing dignity, etc., through use of formal and informal balance.
 - (3) Construct layouts expressing the principles of simplicity, tone, contrast and character.
- (d) Proportion of the whole and of the units.

- (e) Relation of layout to subject.
- (f) Dummies and paste-ups.
Prepare and construct dummies and paste-ups for school magazine, programmes, exhibition posters.
- (g) Study of common printed forms: tickets, stationery, folders, booklets, programmes, magazines and newspapers, posters.
Redesign tickets, stationery, advertising forms.

4. Colour:

- (a) Basic colour principles: hue, value, chroma, complementaries.
Gather colour areas and classify.
- (b) Colour theories: Prang, Munsell, Ostwald.
 - (1) Design colour charts using colour areas made in the print shop.
 - (2) Make a value scale using printing inks.
- (c) Colour in printing papers and inks.
 - (1) Make a survey of colour in paper stock and inks.
 - (2) Learn trade colour terms.
- (d) Colour schemes: tints, shades, seasonal colours, advancing and receding colours.
 - (1) Mix tints and shades from standard printing inks.
 - (2) Develop colour schemes in printing lino blocks.
 - (3) Create colour schemes on coloured stock in the production of school printing.
- (e) Gather samples of colour combinations from printed matter.

5. Methods of Reproduction:

- (a) Study of autographic blocks: lino, woodcuts, wood engraving, colour blocks.
 - (1) Assemble a group of various types of printing surfaces.
 - (2) Visit an engraving shop.
- (b) Designing, cutting and printing blocks for school printed matter.
 - (1) Design, cut and print a one-colour lino block.
 - (2) Design, cut, register and print for school use two and three-colour lino or rubber blocks.
- (c) Silk screen methods.
 - (1) Study principles, equipment and materials used in silk screen process work.
 - (2) Design and print a school poster with silk screen.
- (d) Art requirements and limitations of reproduction.
 - (1) Create suitable illustrations in pen and ink and wash for line and half-tone printing.
 - (2) View one, two, three and four-colour reproductions through a microscope.
 - (3) Gather samples and compare the relative differences in 60 to 120-line half-tone plates.

- (4) Make an enlarged drawing of the screen pattern of a half-tone plate.
 - (5) Compare half-tone and Ben Day screens.
 - (e) A brief study of modern printing methods, particularly the relation to colour, illustration and layout.
 - (1) A review of type, layout, colour, with comparisons with older printing.
 - (2) Practical tests and examinations on content of course.
 - (f) Advertising methods in use to-day.
 - (1) Trace the progress and operations of advertising from its need through a print shop to final use.
 - (2) Prepare a simple advertising campaign. Write the copy, design the printing needs and indicate the complete procedure.
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DRAFTING

RELATED INSTRUCTION FOR STUDENTS SPECIALIZING IN AUTO MECHANICS

GRADES XI AND XII

1. Blueprint Reading (Mechanical and Electrical):

Using automotive manuals, charts and suitable current automotive literature, select instruction material which is closely related to the major shop course in motor mechanics and which will give the pupils training in the following:

- (a) Identification of materials and parts by drawing attention to the symbols employed.
- (b) Determination from the drawings of the order of procedure and devices for assembly and dismantling.
- (c) Observation of devices and means such as are used to—
 - (1) prevent wear, vibration, etc.;
 - (2) obtain desired linkages and movement control;
 - (3) obtain desired mechanical security under normal working conditions.
- (d) Observation of drafting principles employed such as—
 - (1) symbols;
 - (2) selection of views;
 - (3) use of sections, isometric or oblique projections, other projections;
 - (4) materials employed in fabrication.
- (e) Use of catalogues and handbooks showing “outline” or “dimensional” drawings of tools and parts.
- (f) Simple blueprint reading tests on general orthographic layout.

2. Mechanical Drafting:

Using automotive parts, some aeronautical parts may be included, plan a series of projects to develop and maintain a working knowledge of the basic principles of mechanical drafting through drawing construction. The pupils' drawings may be accepted in the following forms—

- (1) good working sketches in pencil;
- (2) instrumental drawings in pencil or ink.

Principles—

- (1) placement and construction of views;
- (2) use of standard lines and symbols;
- (3) sectional detail and assembly.

3. Electrical Drafting:

Using electrical apparatus common to automotive equipment, plan projects to give instruction in the basic principles of electrical drafting through drawing construction. The pupils' drawings may be accepted in the forms referred to under Part 2 of the foregoing.

Principles—

- (1) interpretation and representation of symbols as required for the projects selected;
- (2) construction of circuits in sequence of difficulty.

NOTE:—It is recommended that at least 50 per cent of Part 2 and Part 3 be freehand sketching.

DRAFTING

RELATED INSTRUCTION FOR STUDENTS SPECIALIZING IN CARPENTRY GRADE XI

When practicable, draw the structure or sections that are to be built in the woodwork shop.

Special emphasis to be placed on:

- (a) Layout.
- (b) Specifications.
- (c) Dimensions and notes.
- (d) Sketching.

1. Sections—details of:

- (a) Foundation.
- (b) Detail at sill.
- (c) Cornice.
- (d) Beam construction.
- (e) Interior partitions—
 - (1) bearing partitions;
 - (2) non-bearing partitions.

2. Working Drawings of Basement Plan, showing:
Walls and footings, piers—beams, windows, doors, stairs, chimney, furnace, fuel storage, drainage, electrical layout (switches and outlets).
3. Working Drawings of First Floor Plan, showing:
Walls (exterior and interior), windows, doors, stairs, living room, dining-room, kitchen, bathroom, bedroom, electrical layout.
4. Sections of Building:
Floor levels, grade line, roof pitch, stairs.
5. Elevations:
Footings, walls, roof, cornice, chimney, windows, doors, steps.
6. Blueprint Reading:
A study of blueprints obtained from the construction field.

GRADE XII

Emphasis to be placed on:

- (a) Building Code.
- (b) Sketching.
- (c) Estimating.
- (d) Constructions.

1. Plot Plan:
Street line, sewer and water, excavating, forms, permits and fees.
2. Framing Drawings:
Door opening, window opening, arch opening, floor framing plan, roof framing plan, wall frame.
3. Construction and Use of Mouldings.
4. Working Drawing and Full Size Sections:
Double hung frame, casement frame, door and frame.
5. Drawing and Detailing Small Timber Truss.
6. A Study of Blueprints Obtained from the Construction Field.

DRAFTING

RELATED INSTRUCTION FOR
STUDENTS SPECIALIZING IN APPLIED ELECTRICITY

GRADE XI

This part is to be regarded as a basic unit for all students electing the electrical option (electronics excepted), regardless of any future specialization. The student's work may be accepted in the various forms—

- (1) neat free-hand sketches; (2) instrumental drawings in pencil;
- (3) instrumental drawings in ink.

The drafting room should contain illustrative equipment sufficient for all the basic symbols introduced, and a close co-ordination should exist between studies in this course and those of the major electrical course which the student is following.

Course:

1. Electrical symbols as required.
2. Simple annunciator circuits.
3. Residence circuits from architect's plans.
4. Wiring diagram for family-size electric range.
5. Control circuits as for furnaces, water heating and refrigeration equipment, farm water supply, etc.
6. Installation and control circuits for D.C. motors and generators including starting and field control rheostats, undervoltage and no field protection.
7. Development of sine waves for current, voltage and power.

Option:

In schools where a department of applied electronics has been established the course in related drafting may vary from the foregoing course and should be designed to correlate more closely with studies in electronics.

GRADE XII

The course in electrical drafting for Grade XII should include:

1. Interpretation (blueprint reading) of installation circuits and equipment.
2. Construction of circuit diagrams closely related to the student's studies in the major course.
3. Construction of drawings involving the basic principles of mechanical drafting as applied to mechanical equipment used in the electrical trade.

A selection of work should be made from such as:

1. Motor and generator winding and connection diagrams.
2. Installation equipment, diagrams and specifications.
3. Switchboard wiring and mountings.
4. Transformer connections and lighting and power circuits.
5. Industrial control devices and installations.
6. Meter connections and location in circuits.
7. Radio circuits and general electronic control devices and installations.

DRAFTING

RELATED INSTRUCTION FOR STUDENTS SPECIALIZING IN SHEET-METAL PRACTICE

GRADE XI

1. Parallel Line Development, such as:

Two-pieced 45° round pipe elbow, four-pieced 90° round pipe elbow, ordinary tee-pipe (same diameters), inclined branch (same diameters), tee-branch (branch smaller), eavestrough mitre 90° outside, eavestrough mitre 90° inside, eavestrough mitre other angle, eavestrough outlet, rectangular 90° elbow, flat rectangular 90° elbow, double register box, single register box.

2. Radial Line Development, such as:

Ordinary funnel with collar, roof jack with flashing, tapered measure with flaring lip, simple roof ventilator, fruit scoop, tapered pipe flat one side.

3. Triangulation Development, such as:

Rectangular pitched covers, square to rectangle taper on centre, rectangular reversible, round taper concentric, round taper eccentric, square to round taper, rectangle to round taper off centre, roof chimney saddle, oval to rectangle off centre.

4. Blueprint Reading and Estimating.

NOTE:—All patterns to be developed in the manner employed in good trade practice.

GRADE XII

1. Parallel Line Development, such as:

Five-pieced 90° elbow side seam, elbow intersecting round pipe, elbow intersecting square pipe, collar intersecting an elbow, inclined branch offset, complete ventilator, offset square pipe, compound offset square pipe, rectangle to rectangle transition in corner.

2. Radial Line Development, such as:

Round pipe on taper, round pipe tapered elbow.

3. Triangulation Development, such as:

Round to ellipse, square to round roof fitting, round to round tapered elbow, square to round tapered elbow, rectangle reversible elbow, equal angle equal diameter Y, unequal Y, two-way bull-head Y, oval to round Y with elbows, two-way Y flat one side, oval to round 90° elbow, double rectangular elbow, three-way Y in line.

4. Blueprint Reading and Estimating.

ELECTRICITY

RELATED INSTRUCTION FOR
STUDENTS SPECIALIZING IN AUTO MECHANICS

GRADES XI AND XII

Laboratory Course in Electrical Theory and Testing:

1. Review experimentally: conductors, non-conductors, simple series and parallel circuits, resistance, current and voltage measurement, Ohm's law, electro-magnetic effects and laws as related to and within the range of the automotive field.
2. Induced currents: production of induced currents, including the elementary laws of induction relating to the direction and value of induced pressure with special reference to (1) the automotive ignition coil, (2) magnets, (3) D.C. generator and motor.
3. Storage battery: construction, theory of operation and behaviour characteristics during charge and discharge; care and maintenance with special precautions in handling.
4. D.C. generator and motor: construction, theory of operation, and characteristics of automotive generators and starting motors, and laboratory methods of locating faults; study of characteristics of fan and other auxiliary motors.
5. Condensers: a study of the function of capacity in circuits with special reference to the condenser across the breaker points.
6. Auxiliary automotive electrical apparatus: study of construction and theory of operation of electrical gauges, meters, heat indicators, etc.
7. Voltage and current regulators: construction, purpose and theory of operation, laboratory adjustments and methods of by-passing.
8. Optional: short laboratory course in radio mechanics leading to principles involved in radio installation and minor repairs.

MACHINE SHOP PRACTICE

RELATED INSTRUCTION FOR
STUDENTS SPECIALIZING IN AUTO MECHANICS

GRADES XI AND XII

NOTE:—Owing to the limited time available for related shop studies, it is suggested that standard operations or exercises replace, where advisable, the use of projects as media of instruction.

General Information Topics—Grades XI and XII:

The following topics should be introduced as required and as the course progresses. Teachers should plan activities in order to make certain their students have a good working knowledge of these topics.

Lubrication of machines.
 Cutting lubricants.
 Cutting speeds.
 Thread forms and standards.
 Lead and pitch of screws.
 Letter and number sizes of drills.
 Tap drills.
 Fasteners: bolts, nuts, cap screws, set screws, studs, rivets, taper pins, and keys.
 Rakes and clearances of lathe tools and the theory of cutting tools.
 Fits: shrink, press, running.
 Tolerances.
 Definition of backing off of taps, milling cutters, etc.
 Marking materials: blue vitriol, prussian blue, soapstone, chalks, etc.
 Lacing belts.
 Metals: nature and use of irons, steels, brasses, babbitt, alloys.
 S.A.E. markings of steels.
 Spark test of metals at the grinder.
 Construction and use of hand tools: files, stock and dies, hack-saws, etc.

GRADE XI

Standard Operations:

1. Bench:

Filing: a flat surface, to a layout; sawing: solid bars, tubes, sheet metal; layout: use of dividers, scribe, straight-edge, surface gauge, hermaphrodite calipers, gauges, square, etc.

2. Forge:

Simple forging operations; hardening, tempering, and annealing carbon steel.

3. Lathe:

Squaring a shoulder; setting up work in four-jaw independent chuck; lining lathe centres; turning work parallel and to size, checking micrometers; filing in the lathe; polishing; mounting and turning work on an arbour; cutting external threads.

4. Shaper:

Set-ups; shaping of horizontal and vertical flat surfaces; setting the length and position of stroke.

5. Miller:

Milling machine set-ups in the vice and secured to the table; milling flat surfaces; dividing-head set; cutting a spur gear.

6. Drill Press:

Drilling speeds and feeds for carbon and high speed drills; drilling set-ups; drilling to a layout.

7. Grinder:

Sharpening tools, such as chisels, scribes, centre punches; adjusting work rest, hood, and observing safety practices.

GRADE XII

1. Bench Work and Hand Tools:

Filing parts (1) to size, (2) to a fit; scraping (1) brass and babbitt bearings, (2) a flat surface; using gauges—screw pitch gauge, thickness gauge, depth gauge, centre gauge; balancing a rotor or pulley on levelled parallel bars; taking measurements with (1) the vernier caliper, (2) the inside micrometer.

2. Layout Operations:

Using layout equipment: parallel bars, combination set, "V" blocks, hook rule, key-seat clamps, test dial indicator.

3. Forge:

Simple forging operations; heat treating of steels; case hardening.

4. Lathe:

Grinding lathe centres; cutting left-hand threads; turning and fitting a taper to a gauge; making face-plate set-ups; drilling, boring, and reaming in the lathe; brass turning—the brass-turning tool; using centre rest, follower rest, and cat head; straightening a shaft.

5. Shaper:

Making shaper set-ups; shaping angular surfaces.

6. Milling Machine:

Operations involving various set-ups and feeds; cutting a key-seat in a shaft; side milling; helical milling (demonstration only).

7. Drill Press:

Operations involving drilling set-ups; tapping on centre; reaming on centre; drill jigs.

8. Grinder:

Sharpening a scraper; sharpening a reamer; sharpening a drill for steel; sharpening a drill for brass; sharpening tools for lathe and shaper; safety code for grinding machines: hoods, work rests, periphery speed of grinding wheels, flange sizes, mounting grinding wheels; selecting a grinding wheel for a given machine according to shape, abrasive, bond, and periphery speed.

MACHINE SHOP PRACTICE

RELATED INSTRUCTION FOR STUDENTS SPECIALIZING IN DRAFTING

GRADE XI

NOTE:—Owing to the limited time available it is suggested that training in standard operations replace the usual method of making projects. The prime purpose of this course is to familiarize students with the limitations and possibilities of machine tools.

Operations

1. Bench:

- (a) Layout—involving use of square, dividers, scriber, rule, herma-phrodite calipers, prick punch and ball peen hammer.
- (b) Filing—irregular filing to a gauge or layout; selecting files for specific uses; draw and cross filing.

2. Drill Press:

Drilling flat and cylindrical work in cast iron, steel, brass, aluminum and alloys.

3. Lathe:

- (a) Turning—straight (rough and finish), shoulder and irregular; use of three and four-jaw chucks and reversal of chuck jaws. Radius turning and grooving with formed tools.
- (b) Tapping—using three-jaw chuck.
- (c) Drilling and boring.
- (d) Threading—cutting a national course or acme thread to a shoulder, cutting left and right-hand threads.
- (e) Taper turning—using offset method.

4. Shaper:

Shaping (1) a horizontal surface with hand and automatic feed, (2) vertical and angular surfaces.

5. Miller:

- (a) Slab milling—horizontal surfaces, external and internal surfaces with side or face milling cutter; rectangular piece; hexagonal piece.
- (b) Straddle milling.

GRADE XII

Operations

1. Bench:

- (a) Layout—from the surface plate.
- (b) Filing—flat and to contours with increasing standards of accuracy.

2. Drill Press:

Drilling to a layout; drawing centres; removal broken drills; reaming; boring; tapping; employment of jigs.

3. Lathe:

Turning to close limits; thread cutting both external and internal; multiple threads; eccentric turning; trueing shaft and testing by dial indicator; cutting taper by taper attachment method; reaming; boring to gauge with taper attachment.

4. Shaper:

Shaping (1) concave or convex surfaces, (2) tongue or groove.

5. Miller:
- (a) Milling a keyway.
 - (b) Grooving.
 - (c) Gear cutting.
 - (d) Spiral milling.
 - (e) Differential indexing.
 - (f) Vertical head milling.
6. Heat Treatment:
- Operations involved in the heat treatment of carbon and high speed steel.
-

MACHINE SHOP PRACTICE

RELATED INSTRUCTION FOR STUDENTS SPECIALIZING IN ELECTRICITY

NOTES:—(1) Owing to the limited time available for related shop studies, it is suggested that standard operations or exercises replace, where advisable, the use of projects as media of instruction. Such operations, however, should be directly applicable to the electrical field and, where feasible, carried out on electrical equipment.

(2) Arrange the presentation of instruction to include the necessary related information which should be introduced as required with the trade operations.

GRADE XI

Operations

1. Bench:
- (a) Filing.
 - (b) Riveting.
 - (c) Sawing (hand back-saw).
2. Lathe:
- (a) Centering.
 - (b) Selecting feeds.
 - (c) Turning (steel), rough and finish.
 - (d) Using compound rest, steady rest.
 - (e) Knurling.
 - (f) Cutting one type of thread common to electrical equipment.

GRADE XII

Operations

1. Lathe:
- (a) Turning (1) finish in brass or bronze, (2) for press and running fits.
 - (b) Polishing.
 - (c) Trueing shafts.
 - (d) Under cutting (commutators).
 - (e) Drilling, including grinding of drills for various purposes.
 - (f) Threading—types common to electrical equipment.
 - (g) Boring.

2. Miller:
 - (a) Milling a flat on a shaft.
 - (b) Milling a keyway.
3. Miscellaneous:
 - (a) Winding springs.
 - (b) Scraping bearings.
 - (c) Winding coils in lathe, using lead screw.
 - (d) Straightening bent armatures and checking with indicator.
 - (e) Filing a key for a shaft.
 - (f) Brazing.
 - (g) Drilling and tapping.

MACHINE SHOP PRACTICE

RELATED INSTRUCTION FOR PATTERN-MAKING SPECIALS

NOTE:—Owing to the limited time available it is suggested that where feasible standard operations or exercise work replace the use of projects.

GRADE XI

1. Metallurgical Work:

Ferrous and non-ferrous metals in general use; normalizing and annealing; melting points; hardness tests. Casting defects—blowholes, cold shot, shrinkage cracks.
2. Hand Tools, Bench Work and Layout:
 - (a) Measuring and layout tools, calipers, scale, punches, hermaphrodites; layout material—chalk, copper sulphate, prussian blue.
 - (b) Practice in filing, layout, drilling and tapping of cast iron, aluminum, brass, bronze, babbitt. File and scrape a split metal pattern and insert dowel pins.
 - (c) Layout from the blueprint of a simple casting where several different machining operations are involved in order to check machine allowance, shrinkage, and warp.
3. Machine Work:
 - (a) Cored holes—advantages; difficulties in machining cored holes—when sand ruins tools.

Types of work where cored holes have little advantage. Gap bed lathes for large diameter work. Metals and operations requiring coolants or lubricants.
 - (b) Tool grinder—pedestal; wheel trimming; grits, grades, and shapes of wheels.
 - (c) Simple operations on the lathe, shaper, drill press, and milling machine to enable a study of the speeds, feeds, chips, cutting tools and depth of cuts. Assembly methods of holding machinery parts together.
 - (d) Safety precautions for high-speed machines as are found in wood shops; machine lubrication.

4. Machine Parts—Nomenclature and Uses:

- (a) A study and discussion of machine parts in common use, such as a base, bracket, boss, pillow block, column, coupling, flywheel, hanger, knee, leg, pedestal, rack, table.
- (b) Uses of or need for a tongue and groove, assembly opening, boss, dovetail, hub, spigot, tee slot.

GRADE XII

1. Metallurgical Work:

- (a) Heat recording devices—the thermocouple and pyrometer; segar cones.
- (b) Study of different grades of cast iron after machining to show the granular structure and its corresponding physical characteristics.
- (c) Observation and discussion of parts of machine tools and the reasons for the selection of the materials used in construction.
- (d) Seasoning of castings to overcome warp and wind, methods employed.
- (e) Chilled surfaces on castings, uses, procedure.
- (f) Use of handbooks to determine the physical properties of metals.

2. Layout, Hand Tools and Bench Work:

- (a) Layout and methods of attaching patterns on metal plates.
- (b) Checking castings for size and defects preparatory to layout.
- (c) Uses of more advanced layout tools—combination set, surface plate and table, surface gauge, parallel strips, parallel and “C” clamps.
- (d) Bridges used in cored holes as assists in machining.
- (e) Repair methods to remedy casting defects—plugs, brazing, welding.

3. Machine Work:

- (a) Sequence of operations in machining a casting which requires a variety of machine operations.
- (b) Aids required in castings to facilitate machining—lugs, bosses, etc.
- (c) Proper draft in cored holes to obviate excessive machining.
- (d) Difficulties encountered where cored hole has shifted or is out of proper alignment.
- (e) Clamping to avoid stresses or distortion.
- (f) Securing work in face-plates, chucks, vises, angle-plates, jigs or fixtures.
- (g) Machining allowances.
- (h) Trimming metal patterns—uses of portable grinder.

4. Machine Parts—Nomenclature and Uses:

- (a) Further study of the more important machine parts at hand, their location, function—apron, rocker arm, bearing cap, braces, bushing, cam, counterweight, cover plate, collar, cylinder, eccentric, flange, gib, housing, link, lug, quadrant, quill, rail, saddle, tongue piece.
- (b) Uses and needs of the following for machining—fitting strips, fillets, ribs, cast slotted holes, taper and parallel gibs, good grade metal for surfaces subject to wear such as slides.